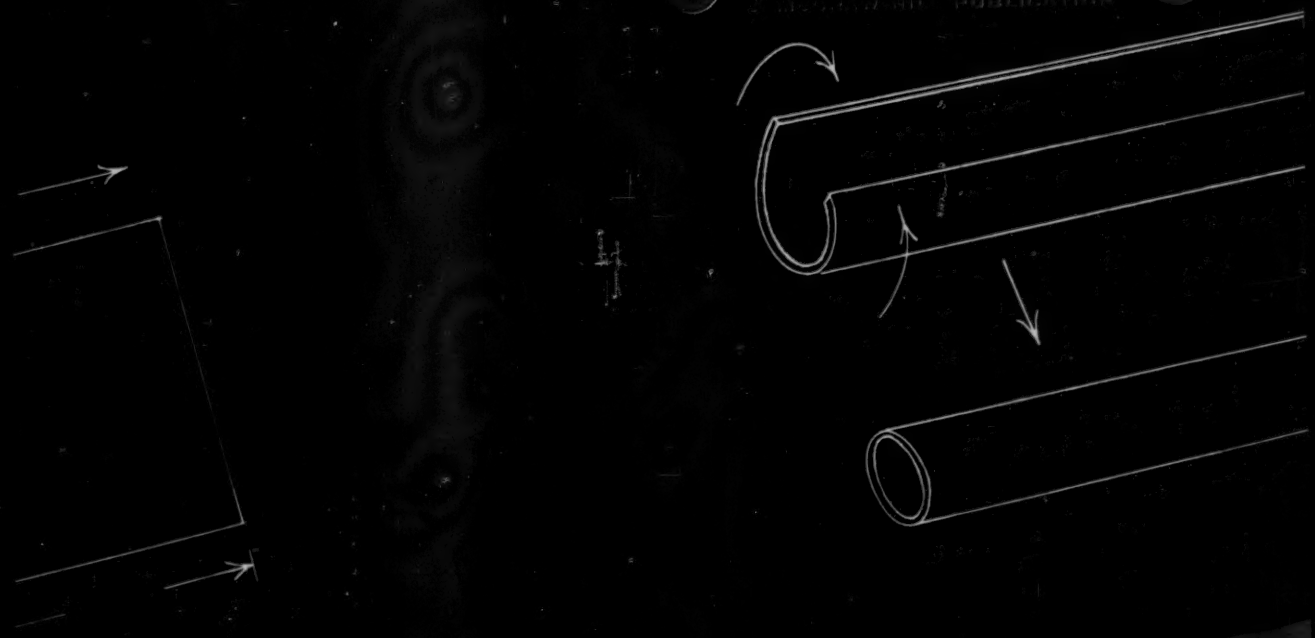
APRIL 4, 1960
Published every-other-Monday
Seventy-five cents

Chemical Engineering



REAPPRAISE WELDED TUBES

SAVES $36,650. First Year!

EIMCOBELT CONTINUOUS BELT DRUM FILTERS

A processor replaced a battery of plate and frame filter presses with two EimcoBelt filters for dewatering corn grits — with these results:

- **The EimcoBelt filters handle this sticky, high-protein slurry continuously, with no blinding . . . no fall-off in rate.**
- **With about one-tenth of the filtration area, the EimcoBelts produce at eleven times the rate of the plate and frames.**
- **Labor costs were reduced from $42,000 to $10,-500 a year . . . power costs from $1,750 to $600. Elimination of cloth replacement saves an additional $4,000 every year.**

These big gains in performance and lower costs were made filtering a slurry that had never been filtered before, successfully, on vacuum filters!

Corn grits is only one of several difficult, hard-to-filter slurries now being filtered continuously and profitably on EimcoBelt continuous belt drum filters.

The Eimco representative near you can give you complete facts on the new EimcoBelt filter — Eimco's greatest contribution to the science of filtration. Write Eimco Filter Division for new EimcoBelt Bulletin F-2053.

THE EIMCO CORPORATION

EIMCO

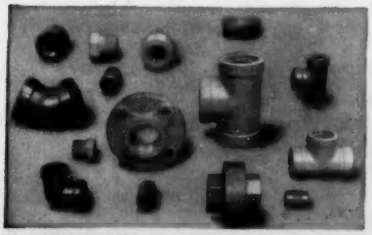
FILTER DIVISION
634 SOUTH 4TH WEST
SALT LAKE CITY, UTAH — U.S.A.

RESEARCH AND DEVELOPMENT CENTER
301 SO. HICKS ROAD, PALATINE, ILLINOIS

Koroseal PVC Pipe *is lightweight, resists acids, corrosion, aging, weather and abrasion. It will not support combustion, is an excellent insulator. Fast, easy installation and long life result in substantial cost reductions.*

Specify Koroseal PVC pipe and fittings for long life at low cost

The more severe the service conditions, the more apparent are the superior properties and quality of rigid Koroseal PVC pipe, fittings, valves and sheet. Koroseal PVC is delivering long, trouble-free service in a multitude of industrial applications where corrosion, chemicals, high pressures and physical abuse ruined other types of pipe in a hurry. And savings are substantial—on original cost, installation costs, reduced maintenance and longer life. Investigate the many advantages of Koroseal PVC pipe now. For details, etc., write Dept. M-826. *B.F.Goodrich Industrial Products Company, Marietta, Ohio.*

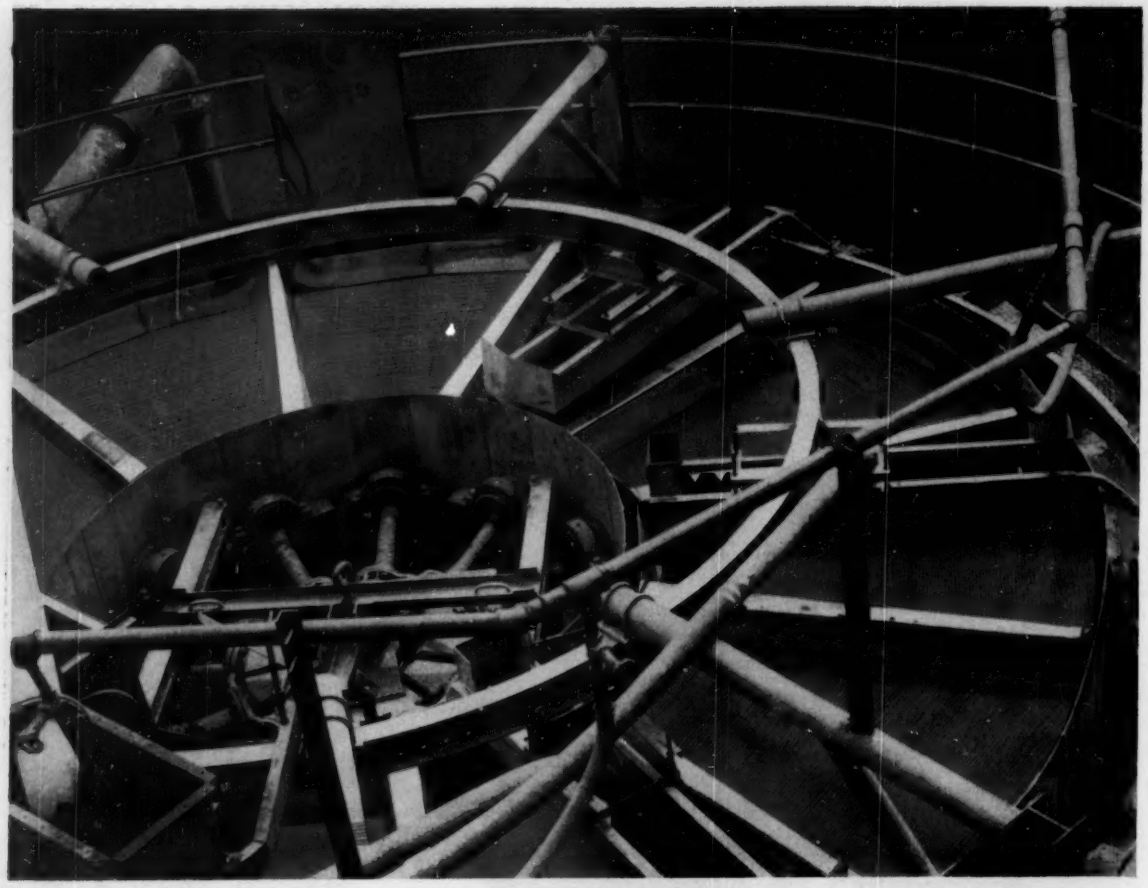


Koroseal PVC Fittings *can be joined to Koroseal pipe by solvent-cementing, heat welding, flanging or threading. Recessed threads protect against damage, eliminate cross threading. There's a size and type for every need.*

Koroseal Valves—*excellent for handling fluids, gases and corrosive materials. Complete selection of diaphragm, ball, and check valves for all types of service. Strainers and other piping components also available.*

Sheet, Tubing, Rods—*Koroseal PVC also is available in other forms . . . sheet and fabrication aids for duct work . . . bar stock for machined parts . . . tubing for special uses.*

B.F.Goodrich *Koroseal rigid PVC products*



Every Tilting Pan Rotary Vacuum Filter in Commercial Operation in the Phosphoric Acid Industry throughout the United States and Canada is a

BIRD-PRAYON FILTER

Why? Because the Bird-Prayon has proved itself over fifteen years of successful performance in this exacting service.

Because the Bird-Prayon provides longer operating cycles than any other type of filter for this service. Its application has come to be standard and routine rather than "trial and error."

Because the Bird-Prayon has piled up a remarkable record of *minimum maintenance* attention and expense.

These factors, plus the Prayon's ability to provide super-efficient wash with no dilution of mother liquor, freedom from cloth blinding and constant high output, may prove profitable to you, too.

Ask us to mail you the latest Bulletin with complete information on the Bird-Prayon Filter

BIRD
MACHINE COMPANY

SOUTH WALPOLE, MASSACHUSETTS
Regional Offices:
EVANSTON, ILL. • ATLANTA, GA. • HUNTINGTON, W. VA.
LA PORTE, TEXAS • ALAMO, CALIF.

April 4, 1960 **Chemical Engineering** Vol. 67 No. 7

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

J. Elton Tuohig, Publisher

•

Cecil H. Chilton, Editor-in-Chief

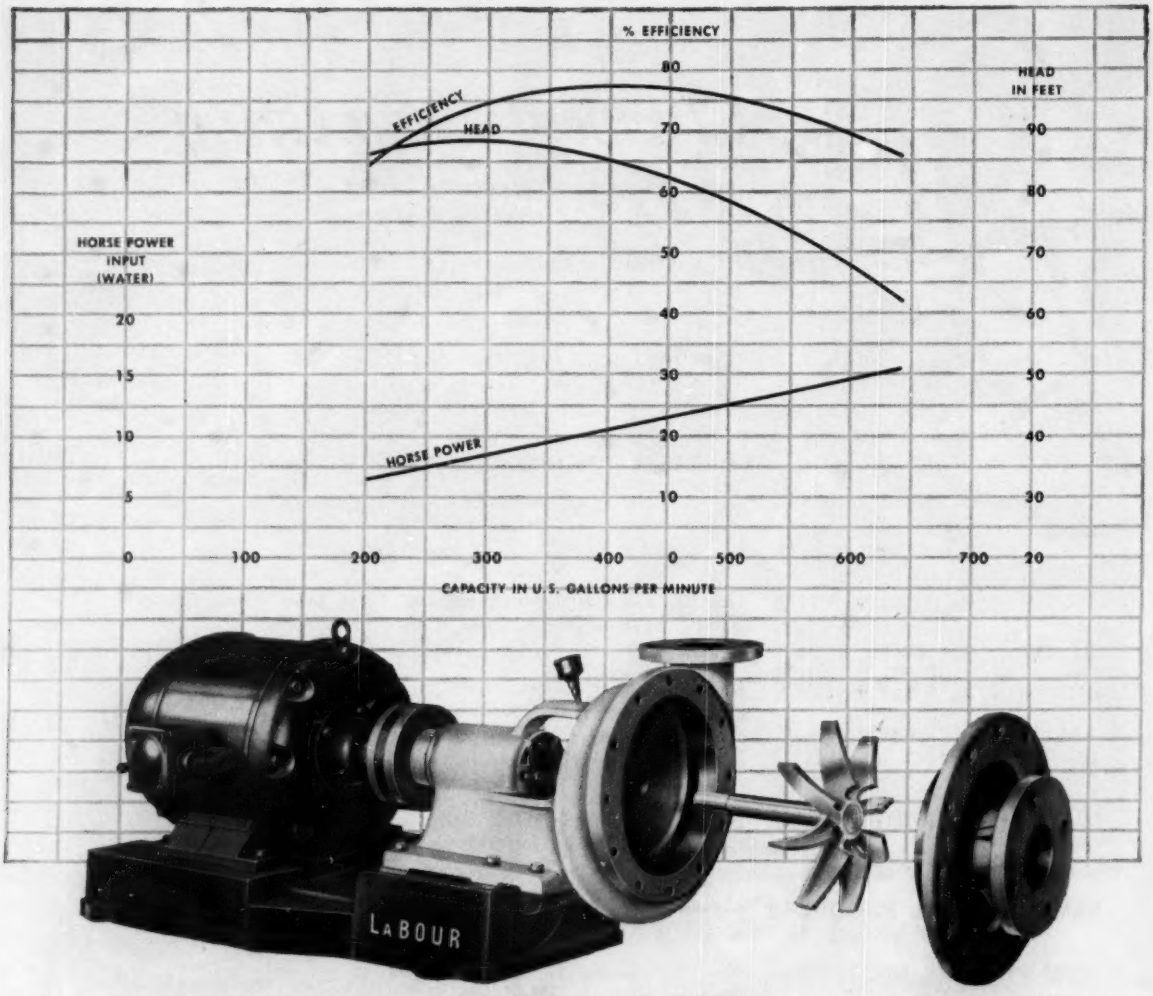
•

CHEMICAL ENGINEERING DEVELOPMENTS
Editor: Calvin S. Cronan.
Associate Editors: Frances Arne, T. Peter Forbath.
Assistant Editors: John B. Bacon, Nicholas P. Chopey, John A. King, Roland A. Labine.

•

CHEMICAL ENGINEERING PRACTICE
Editor: Theodore R. Olive.
Associate Editors: Steven Danatos, Raymond F. Fremed, Robert B. Norden.
Assistant Editors: Peter J. Brennan, William C. Schall.

Contents Continued . . . turn page



And it's done with an *OPEN IMPELLER*

There's no need to give up the many advantages of open impeller pumps for chemical service, in order to obtain higher efficiency. This curve, the actual record of a LaBour No. 20 Type SQ pump, is typical.

Because the performance of a LaBour pump is not dependent upon close clearances inside the casing, substantial increases in clearances have little effect. That's why, even after long, hard service, LaBour pumps *continue* to deliver relatively high efficiency.

We'll be glad to explain why it's to your advantage to insist on fully open impellers, and to insist on LaBour pumps for efficiency without sacrifice of those advantages. Write us today.

ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LABOUR

THE LaBOUR COMPANY, INC. • ELKHART, INDIANA, U. S. A.

Contents, Continued

Chemical Engineering

April 4, 1960

PRINT ORDER OF THIS ISSUE: 51,668

•

Chemical Engineering (with Chemical & Metallurgical Engineering) is published biweekly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. Publication Office: 99-129 North Broadway, Albany 1, N. Y.

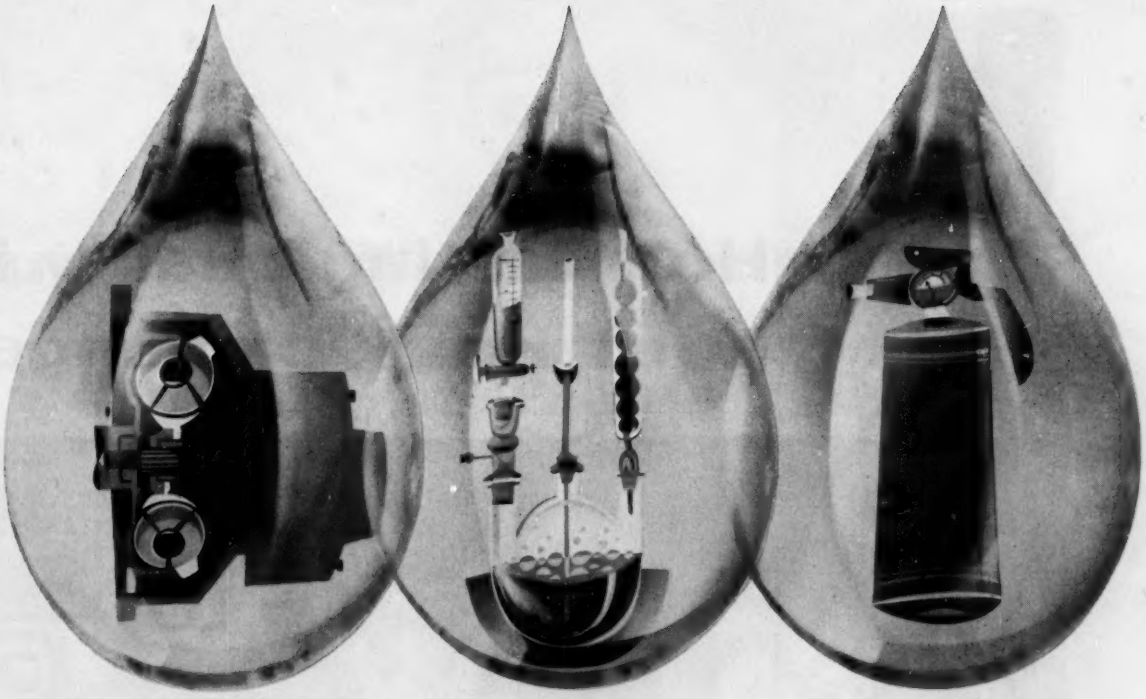
Executive, Editorial, Circulation and Advertising Offices, 330 West 42nd St., New York 36, N. Y. Officers of the Publications Division: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venetian, Vice President and Circulation Coordinator. Officers of the Corporation: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

Subscriptions are solicited from engineers and technical management in the Chemical Process Industries. Position, company connection, and nature of company's business, products, and approximate number of employees, must be indicated on subscription application. Subscription rates per year for individuals in the field of the publication: U. S. and Possessions $3 (single copies 75¢) Canada $4, other Western Hemisphere $15, all others $25. The Publisher, upon written request from any subscriber, agrees to refund the part of the subscription price applying to copies not yet mailed.

Second class postage paid at Albany, N. Y.

Subscriptions: Send correspondence and change of address to Fulfillment Manager, Chemical Engineering, 330 West 42nd Street, New York 36, N. Y. Send notice promptly for change of address, giving old as well as new address. Enclose an address label from a recent issue of the magazine if possible. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Chemical Engineering, 330 W. 42nd St., New York 36, N. Y.



Build High Density Fluids

Bromine is more than three times heavier than water. Hydraulic engineers, for example, find this property valuable in developing high density fluids to make possible more compact hydraulic systems without sacrificing efficiency.

React Fast

Because bromine is highly reactive, it's extremely easy to add bromine onto a compound, or to take it off. With bromine or brominated compounds, the reactions are fast, often avoid undesirable side-reactions, unwanted by-products.

Fight Fire

During World War II, specialized military fire-fighting jobs began to rely on certain brominated compounds for fast action. Use has spread to industrial applications, and current research shows additional bromine compounds of great value.

For years, the unique properties of bromine and brominated compounds have sparked the creative imaginations of scientists. In fact, they've found hundreds of individual uses, and the list keeps on growing! The three characteristics described above stand out in the spotlight of current development work to improve commercial products and processes . . . and to make new ones possible.

Most likely, new developments for *your company* depend on industrial chemicals and technical knowledge to put them to work. When your needs call for bromine or brominated compounds, we suggest you call in Dow. Our latest investigations are in the areas of new fast-acting chemical intermediates, high density fluids and fire-fighting agents.

Besides providing highly pure elemental bromine, Dow also upgrades it into hundreds of compounds–both standard items and chemicals compounded to "prescription." New brominated compounds are constantly being studied. Furthermore, Dow offers its research facilities and vast experience for developing bromine's ability to serve your particular needs. For further information, return the coupon below.

Bromine was Dow's first product. The sketch shows founder Herbert Dow's first plant where, in 1891, he perfected the electrolysis method for producing bromine in commercial quantity from brine wells in Midland, Michigan. Later, Dow pioneered the recovery of bromine from sea water. In the past decade, Dow also pioneered the bulk shipment of bromine. Today, The Dow Chemical Company with expansive modern facilities continues as a major producer of high-quality bromine and its compounds, with nearly 70 years' background of experience and highly developed knowledge.

See "The Dow Hour of Great Mysteries" on NBC-TV

Send coupon today

Chemicals Merchandising Department 650AK4-4, The Dow Chemical Company, Midland, Michigan.

Send information about:

- ☐ Bromine and brominated compounds
- ☐ Chemical intermediates
- ☐ High density fluids
- ☐ Fire extinguisher fluids

We are interested in bromine for use in _____

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

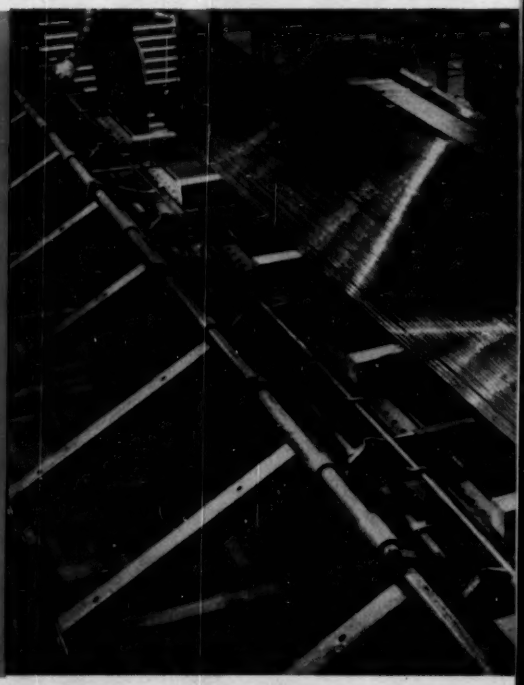
CITY _____ ZONE _____ STATE _____

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

How lasting quality is
Heat Exchanger

4
TESTING

(FOURTH OF A FIVE-PART SERIES)



The quality of Phelps Dodge heat exchanger and condenser tubes is continually controlled at every stage of the entire fabricating operation by a special "in-mill" laboratory. In addition, the finished tubes are given exhaustive physical, chemical and metallurgical tests to assure quality and conformance with specifications.

All physical tests, including hydrostatic, flattening and expansion tests, are performed in strict accordance with ASTM and customer specifications. In the chemical laboratory, samples of the tubes are analyzed both chemically and spectrographically to determine the exact composition and conformance to the specifications. Experienced metallurgists minutely examine the grain structure of the metal in samples of both "in-process" and finished tubes. The grain size and temper are also carefully determined.

Throughout the entire tube fabricating operation—from raw materials to finished product—quality is the keynote. That's why Phelps Dodge tubes are preferred by those who demand the finest . . . the manufacturers and users of heat exchangers and condensers.

built into Phelps Dodge and Condenser Tubes...

Finished tubes receive the hydrostatic test, a quality control check in which water is pumped into the tubes at high pressures.

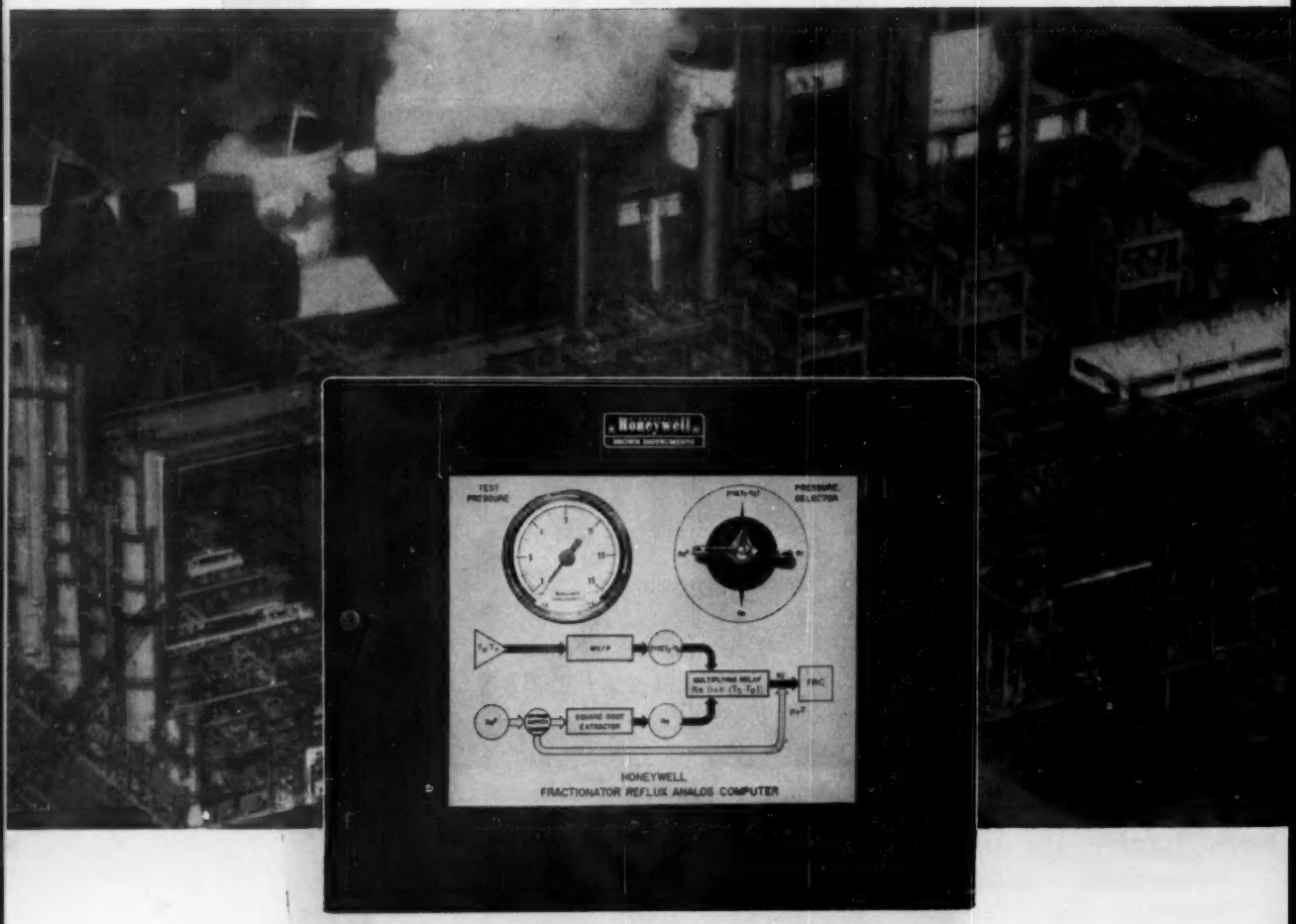
Another quality control test is this multi-frequency eddy current device which helps assure flawless tubes.

PHELPS DODGE COPPER PRODUCTS CORPORATION

First for Lasting Quality—from Mine to Market!

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Denver, Detroit, Fort Wayne, Greensboro, N. C., Houston, Indianapolis, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

Stabilize Fractionating with new Honeywell



HONEYWELL *FRAC* CONTROLLER IS EASY TO USE AND MAINTAIN

- Standard Honeywell components, packaged in a standard Honeywell strip chart recorder case—completely wired and internally piped.
- Only four simple, easily accessible process connections required to put the unit in operation.
- Chassis pulls out for front-of-case servicing, simplifying adjustment and maintenance for your instrument technicians.

COMPONENTS

MV/P (millivolt-to-pressure) Transmitter

- Fully transistorized
- Continuously sensitive to temperature change
- Constant voltage supply
- Simple span and zero adjustments

Pressure selector and test pressure gage

- Provide check of all pneumatic pressures within the computer for simplified trouble shooting.

By-pass switch

- Permits switching from *FRAC* control to conventional external reflux flow control.

Column Operation

*FRAC** Controller

- **Easily installed and maintained by present instrument technicians**
- **Savings realized justify installation**
- **Tamper-proof design**

This new Honeywell control system immediately adjusts column operation to the effects of ambient temperature on overhead product condenser and external reflux. It continuously computes internal reflux flow, to maintain the most efficient, economical fractionating tower operation.

The new method, originally developed and licensed by Phillips Petroleum Company, utilizes a simple Honeywell analog computer employing standard Honeywell electric and pneumatic instrument components.

By correcting instantly for temperature deviation, the new control system offers the following economies.

- Less reboiler heat is required, because large surges of internal reflux that would lower temperature are eliminated.
- Reduction in off-specification product minimizes re-runs and the need for intermediate storage.
- Closer control permits fractionator to operate closer to the flooding point.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

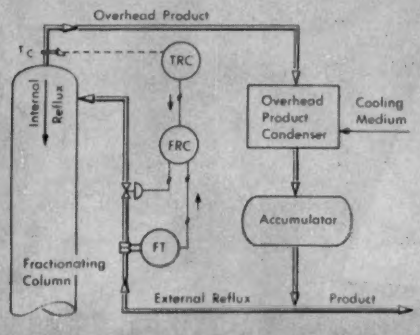
**Fractionator Reflux Analog Computer. Trademark, Minneapolis-Honeywell Reg. Co.*

from Honeywell... ANOTHER DIAMOND JUBILEE PRODUCT

Honeywell

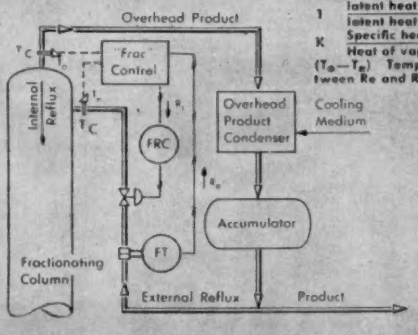
First in Control

SINCE 1885



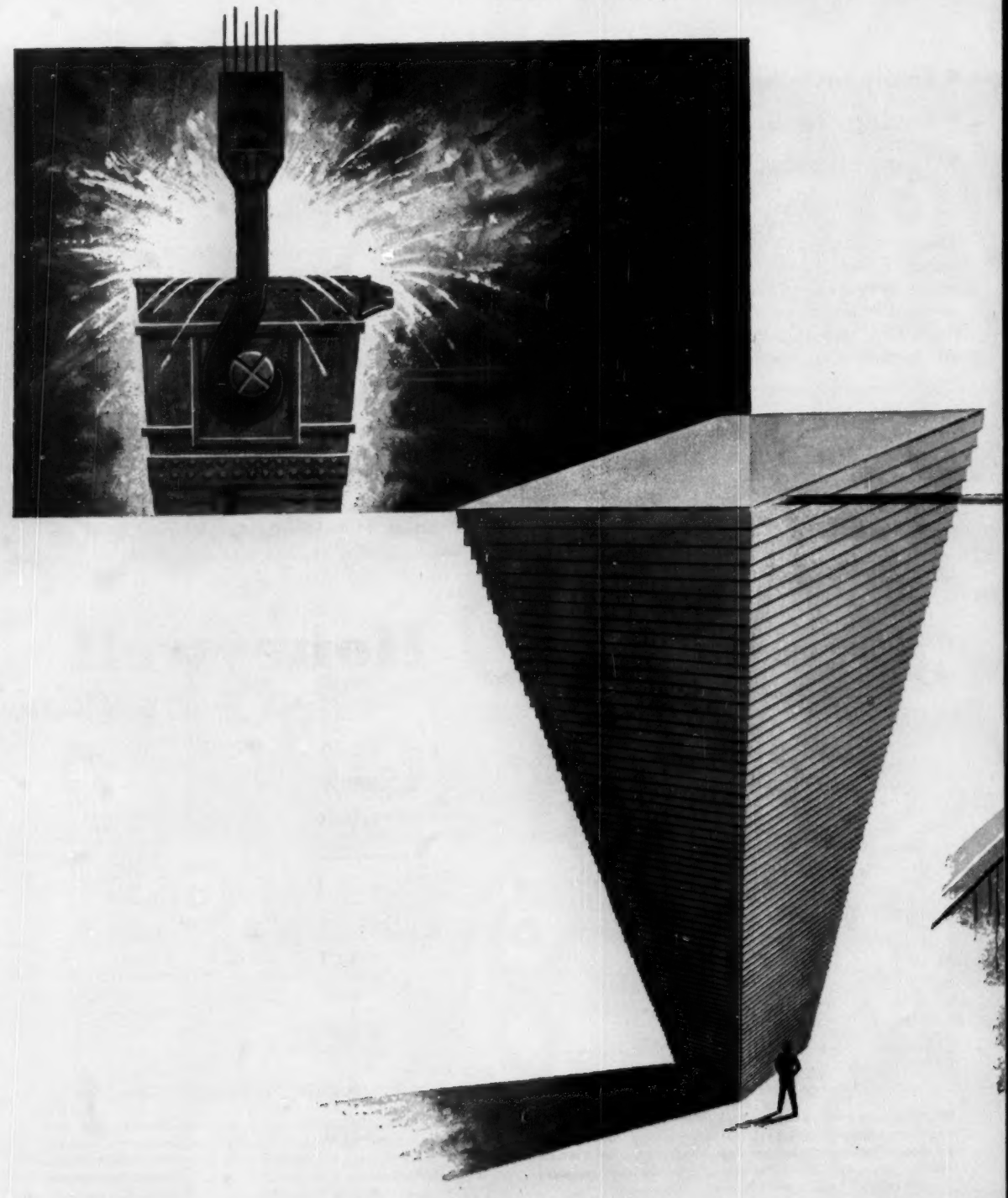
PROBLEM with existing fractionator control systems—Column is upset when temperature of external reflux is indirectly affected by changes in atmospheric conditions or in the temperature of the cooling medium to the condenser. Result: off-spec product, wasted reboiler heat, lower fractionator capacity.

R_i R_e (1 + K (T_o —Te)
R_i Internal reflux
R_e External reflux
1 latent heat of vaporization of R_e / latent heat of vaporization of R_i
K Specific heat of R_e / Heat of vaporization of R_i
(T_o—T_e) Temperature difference between Re and R_i



SOLUTION: FRAC Controller (1) measures external reflux flow rate (R_e) and the temperature difference between the overhead product (To) and the external reflux (T_e); (2) computes internal reflux flow rate (R_i); and (3) holds it constant by adjusting external reflux flow rate for efficient fractionator operation.

WHAT IS CF&I

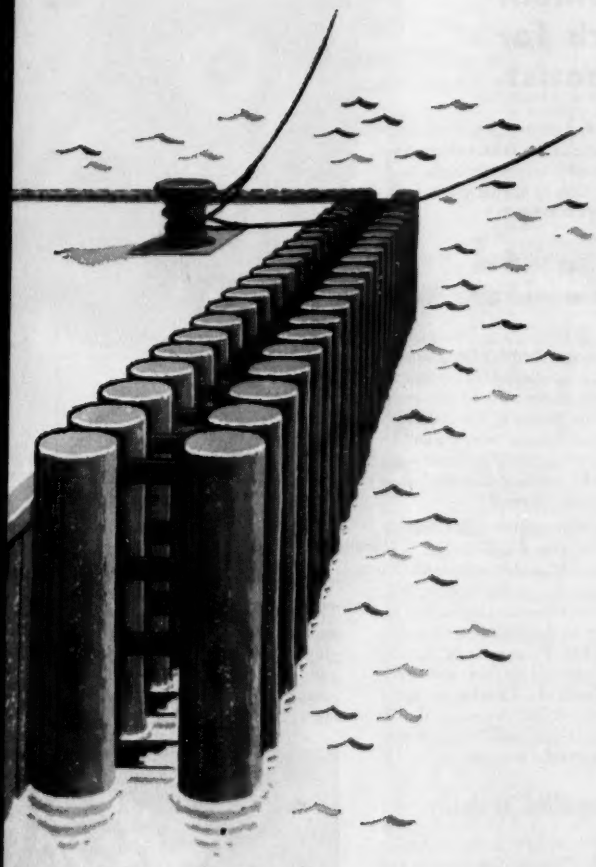


CLAYMONT?

CF&I-Claymont is the heart of a volcano...

a mountain of plates...

a dock on tidewater



Claymont is a vital arm of CF&I, one of the nation's leading steel companies. Claymont is liquid steel, hot as the heart of a volcano, flowing from an open hearth. It is plateau after plateau of steel plates poised for rapid delivery. Claymont is water, highway and railroad shipping facilities that assure rapid, economical shipment of all Claymont products.

Claymont is an integrated steel mill. Here, CF&I's pig iron is converted into quality steel. Then the steel undergoes the constant scrutiny of quality control men as it is rolled into plates and shaped into a wide variety of plate products. The result: built-in dependability which is characteristic of all CF&I steel products.

CF&I-Claymont is also a sales-service force whose job is to serve you properly and promptly, providing you with technical assistance whenever needed.

CLAYMONT STEEL PRODUCTS

THE COLORADO FUEL AND IRON CORPORATION

DENVER • OAKLAND • NEW YORK

sales offices in all key cities

CF&I STEEL

Announcing... for ENGINEERS

The McGRAW-HILL Encyclopedia

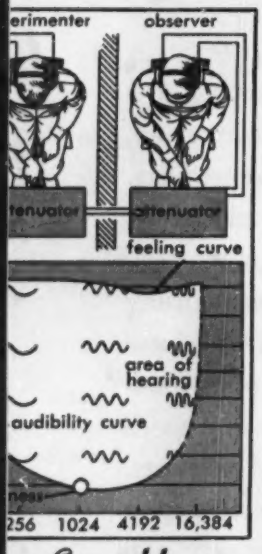
AVAILABLE FOR
A LIMITED TIME AT A

Special INTRODUCTORY PRICE

—at a prepublication savings. The introductory price of $159.00 saves $16 on the regular price of $175.00.

Low Monthly Terms Available

An unprecedented publishing achievement providing a complete reference work for the library of the engineer or scientist.



Superbly illustrated

The McGraw-Hill ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY contains more than 8000 drawings, charts, maps, photographs, and diagrams in both black-and-white and color. All were especially prepared by the finest craftsmen in technical illustration. They reinforce the written information — round out the complete, practical nature of the Encyclopedia.

TODAY'S accelerated pace of technological developments demands a broader scientific background of the technical man. *No longer can a thorough knowledge of only his own specialty assure him of success.* A structural engineer must know about ocean currents before designing an off-shore oil-drilling platform ... a chemist needs a better background in electronics to make full use of instrumentation ... an engineer placing a cross-country pipeline requires knowledge of weather conditions ... a space scientist needs information on human physiological and psychological factors. The McGraw-Hill ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY is designed for needs such as these or others with which you may come in contact. *Nothing remotely like this has ever been done before.*

Your master reference to the world of science and technology

More than 7000 separate articles — many of them by men credited with performing pioneer research in their fields — provide unrivaled breadth of coverage — meet many needs within your range of interests and challenges. The articles range from concise definitions and basic foundation material, to the most modern developments, applications, and discoveries. So skillful and extensive is the cross-referencing that you could follow through to a basic education in virtually any technical or scientific field.

The work of world-renowned authorities

More than 60 Consulting Editors, aided by a distinguished Advisory Board, chose the most outstanding persons in each field to contribute to the encyclopedia. The names of the 2000 contributors read like a "who's who" in the pure and applied sciences — assuring you of the most informed view of each subject covered.

Leading contributors like Glenn T. Seaborg on the transuranium elements; Paul A. Siple on Antarctica; Selman Waksman on antibiotics; P. W. Bridgman on classical mechanics; H. E. Edgerton on deep-sea photography; recent Nobel Prize-winner Emilio Segre on the antiproton and antimatter; Krafft A. Ehricke on space engineering; and others of equal stature — provide you with brilliant coverage of any topic you seek out.

Unequalled in clarity

When you turn to the encyclopedia, you find that the articles explain and illustrate with the utmost skill, clarity, and accuracy. *Complete understanding,* in addition to factual information, keynotes the encyclopedia's approach. The style of treatment enables you to *quickly* get to the depth you want —comprehend the precise area and degree of knowledge you need—in any realm of technological interest or activity.

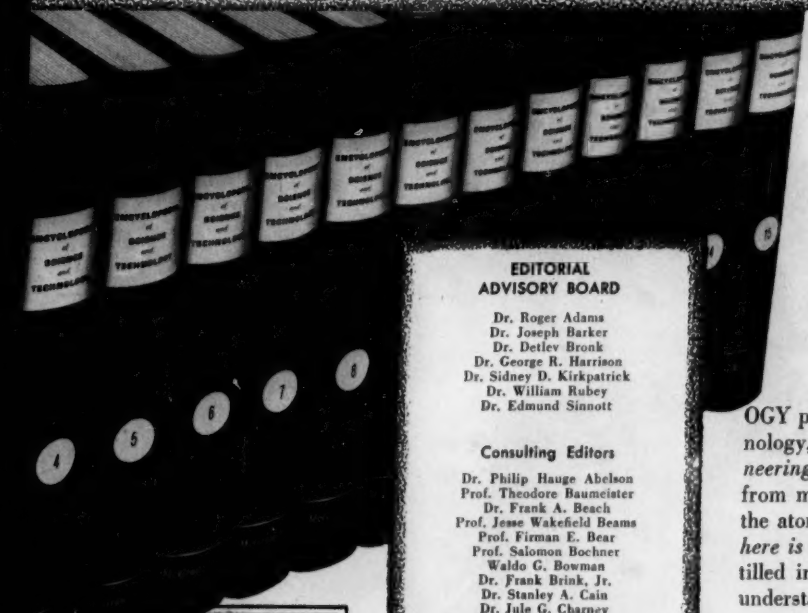
Completely indexed

The Index takes up an entire volume and runs to over 100,000 entries. Specific facts can be located quickly not only through the index, but also by means of the extensive cross-referencing of the 7200 articles.

• 15 volumes • over 2000 contributors • 9300 pages • 7200 articles

for SCIENTISTS for TECHNICIANS

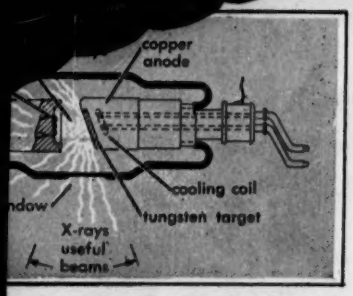
# of Science and Technology



Now — *for the first time in the whole span of technological progress can you have conveniently and inexpensively available a universal reference of technical knowledge.* Never before have so many and such internationally known authorities been enlisted to provide you with the broader, more complete scientific and engineering background required by today's exploding technological developments.

MONUMENTAL in scope... prepared by over 2000 authorities... the McGraw-Hill ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY places at your command the basic concepts, terminology, and modern developments in *every area of engineering and science.* From aeronautics to zoology... from mechanical engineering to oceanography... from the atomic nucleus to the far reaches of outer space... *here is the whole sum of basic technical knowledge* distilled into 15 volumes for ready reference and ease of understanding.

The McGraw-Hill ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY helps you attack more confidently the problems demanding knowledge beyond your particular field... enables you to bridge the gap between your specialty and countless other fields which grow ever closer to your own.



Special techniques of illustration add unusual clarity

Up-to-date

The Encyclopedia reflects facts still in the news — the Van Allen Radiation Belts, the plans to probe the earth's crust to the Moho Discontinuity, artificial satellites, and much more. A YEARBOOK OF SCIENCE AND TECHNOLOGY will maintain the timely accuracy of the Encyclopedia.

Illustrations are accurate, complete; bring out essential details

• 8700 illustrations

Special low prepublication price

To give the Encyclopedia as wide an initial circulation as possible — among the type of readers whose reactions are most important — a special low price, affording a savings of $16.00, is offered.

This offer is limited to orders placed before the Encyclopedia is published. In view of this, we urge you to mail the coupon for further information promptly. Your request now will reserve this price advantage for you, subject of course to your later examination and acceptance of the Encyclopedia.

Write to McGraw-Hill Encyclopedia of Science and Technology
327 West 41st Street, New York 36, N. Y.
Address department CE-4-4

Mail this coupon for full information

Department CE-4-4
McGraw-Hill Encyclopedia of Science and Technology
327 West 41st Street, New York 36, N. Y.

Please send me your Prospectus on the McGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY, with full details of your special price offer and budget terms for Prepublication Subscribers. (No obligation, of course. No salesman will call.)

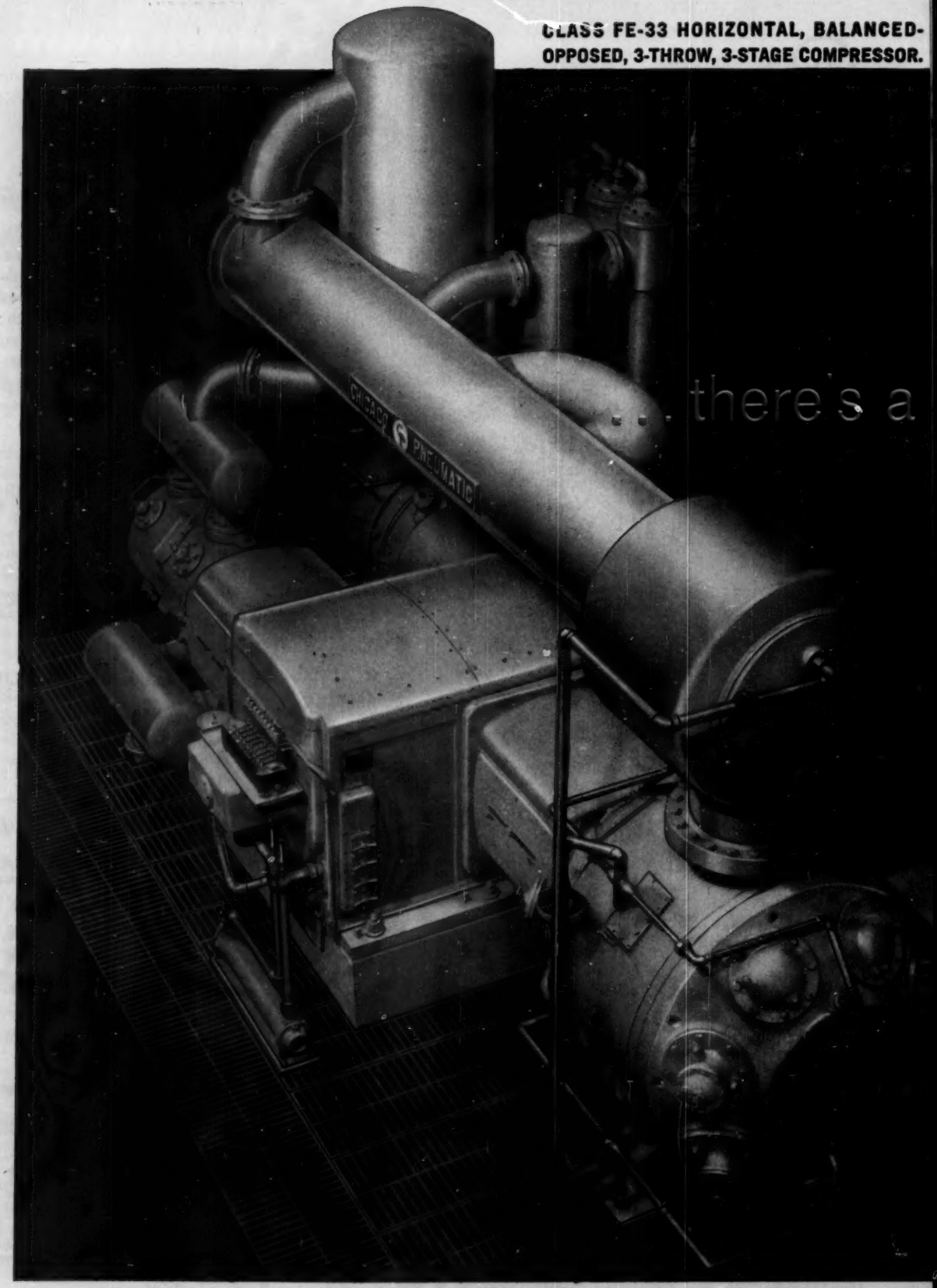
Name.....

Address.....

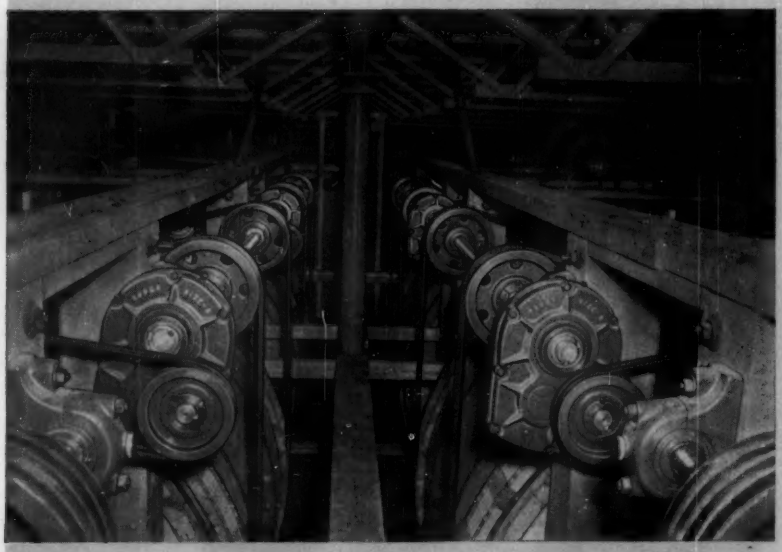
City.....Zone.....State.....

CE-4-4

CLASS FE-33 HORIZONTAL, BALANCED-OPPOSED, 3-THROW, 3-STAGE COMPRESSOR.



. . . there's a



DODGE TORQUE-ARM SHAFT MOUNTED SPEED REDUCER

Install it anywhere—with minimum time and effort. Here is an overhead installation on tanning drums. Torque-Arm reducers are resistant to acid fumes, salt water environment, moisture.

DODGE TORQUE-ARM SHAFT MOUNTED SPEED REDUCER

Can be positioned any place on the entire length of the shaft. It locks into place on *both* sides of the housing. Note modified torque arm on this installation on a mixer in a beverage plant.

The Speed Reducer Idea that

Two things account for the record popularity of Dodge Torque-Arm Speed Reducers. First, they cost less to install since they require no foundations, sliding motor rails or flexible couplings. Second—and most important—these modern reducers as developed by Dodge perform *brilliantly*. Tens of thousands of installations underscore Torque-Arm dependability. Torque-Arm is America's *quality* shaft mounted speed reducer!

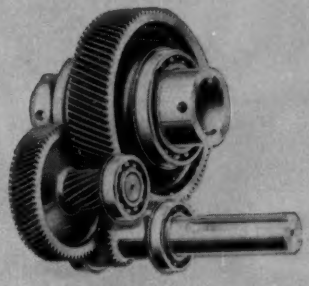
Torque-Arm has been so extensively adopted by industry that today models are available for a vast range of applications. The Torque-Arm line offers you capacities up to 170 hp—output speeds from 10 to 400 rpm—in single and double reduction series—with 5 to 1, 15 to 1 and 25 to 1 ratios. Models for vertical or inclined shaft operation are available—as well as special-application versions such as flange mounted, right

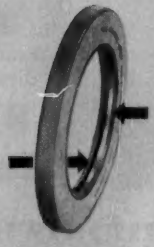
Rugged semisteel housing— a solid backbone for solid service

Here is a tough, corrosion-resistant housing with the strength to hold bearing seats in line for the life of the unit. Perfect shaft and gear alignment are assured by doweling the matched halves together and boring in line. No gear is overhung. Loads are carried easily, contributing to Torque-Arm's long life and high efficiency—97% in double reduction models, almost 99% in single!

AGMA rated gears— quality-guarded by continual tests

These helical gears have soft cores to withstand shock—and hardened surfaces to resist wear. Their quality is guarded in manufacture and assembly by the most modern methods of quality control, including inspection for runout, tooth spacing, helical lead and involute profile. They run quietly, mesh precisely. Teeth are crown shaved for maximum contact area. Gears are shrunk on their shafts to prevent shifting.





Modern double-lip seals keep oil in and dirt out

Modern synthetic, double-lip seals of the highest quality keep oil in and dirt out of the reducer case. These seals offer protection for the unit from dust and dirt and just as effectively insure cleanliness when operating in laundries, textile mills, food processing plants.

Re-ally Clicked!

angle and extended input shaft styles. Optional equipment includes a positive, sealed-in backstop and a positive overload release.

Ask your local Dodge Distributor. Or write us for our 64-page Torque-Arm Speed Reducer Bulletin, complete with engineering data and easy selection tables.

DODGE MANUFACTURING CORPORATION
200 Union Street • Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages

When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

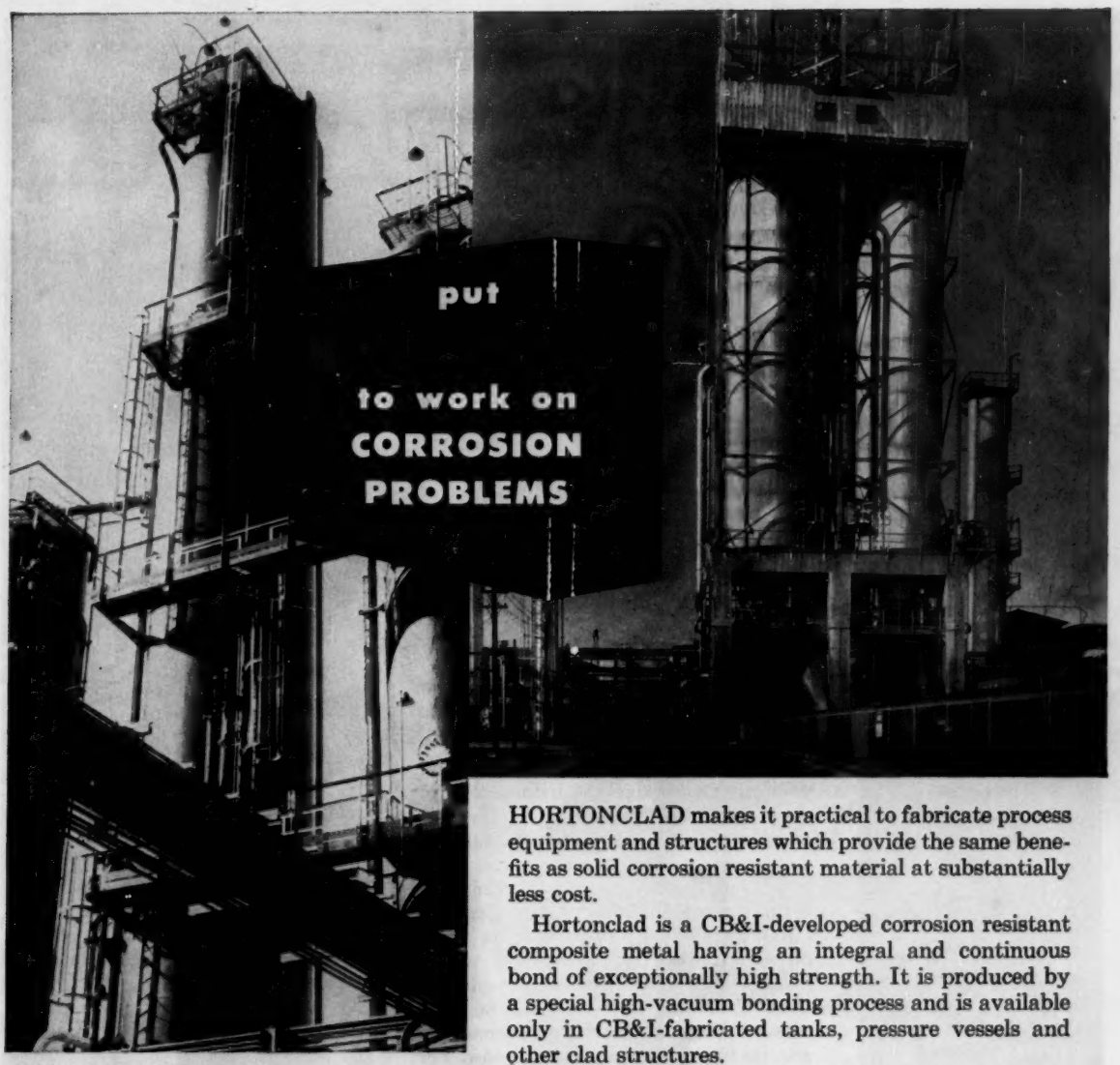
If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1210



(Above)

ABSORBER TOWER at a Louisiana chemical company has stainless steel Hortonclad shell. Thickness of backing and cladding is 1¼ inches.

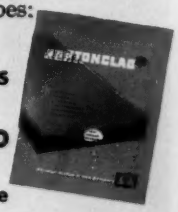
(Right above)

COKING CHAMBER at a Kansas refinery uses 405 stainless steel Hortonclad backed by A205 Grade A moly steel.

HORTONCLAD makes it practical to fabricate process equipment and structures which provide the same benefits as solid corrosion resistant material at substantially less cost.

Hortonclad is a CB&I-developed corrosion resistant composite metal having an integral and continuous bond of exceptionally high strength. It is produced by a special high-vacuum bonding process and is available only in CB&I-fabricated tanks, pressure vessels and other clad structures.

Silver, stainless steels (both chromium and nickel) nickel and alloys such as Monel, Inconel, Hastelloys B and F and a variety of other alloys may be employed in the Hortonclad process. Write our nearest office for a copy of the CB&I bulletin which describes:



. . . the benefits of HORTONCLAD

1. Corrosion resistance
2. Economy of design
3. Uniform thickness of clad and backing plate
4. Integral and high strength bond
5. Wide selection of cladding materials
6. Clean contaminant-free surface

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City(Mo.)
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, GREENVILLE, PA. and at NEW CASTLE, DELAWARE.

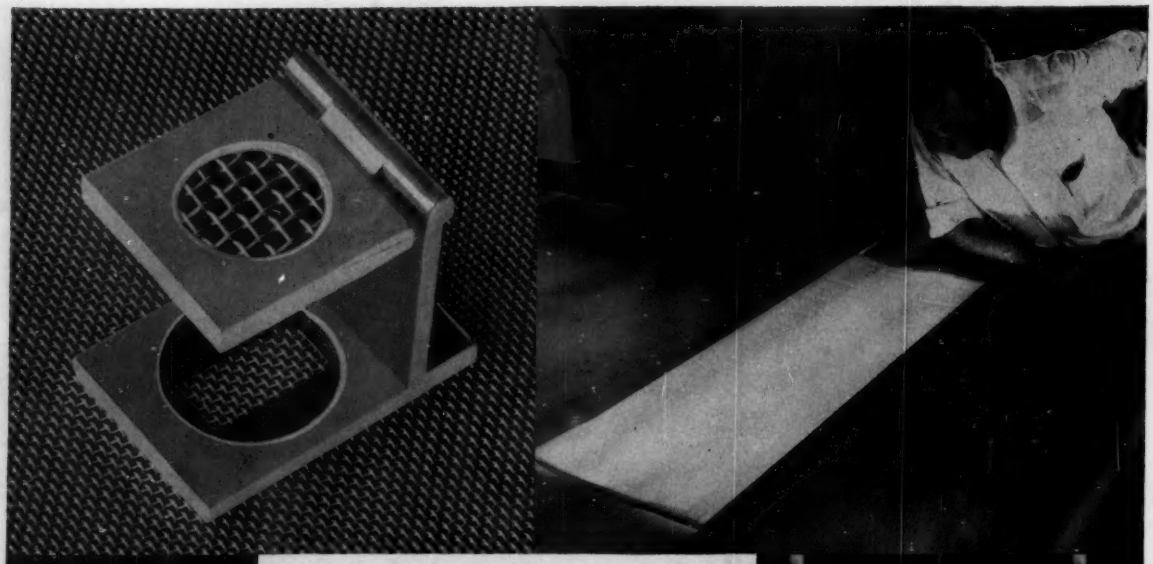
In Canada: HORTON STEEL WORKS LTD., TORONTO, ONTARIO

REPRESENTATIVES AND LICENSEES:
Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

SUBSIDIARIES:
Horton Steel Works Limited, Toronto; Chicago Bridge & Iron Company Ltd., Caracas; Chicago Bridge Limited, London; Sociedade Chibridge de Construcoes Ltda., Rio de Janeiro

CBI

CHC



Who counts 'em?

CAMBRIDGE does . . .

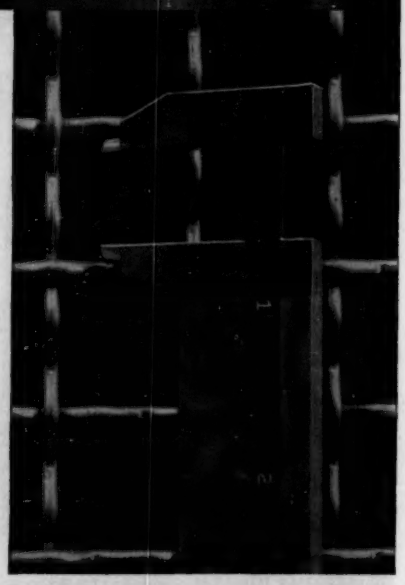
. . . because *exact* mesh count and mesh size are the trademarks of Cambridge INDUSTRIAL WIRE CLOTH.

But, quality isn't the whole story. When you call Cambridge for industrial wire cloth, you also get service . . . prompt answers to your inquiries . . . quicker deliveries . . . and an experienced Field Representative who follows up your order to make sure our product is giving you the best possible service. Let us quote on your wire cloth needs. We manufacture wire cloth from any metal or alloy—including titanium—in nine basic weaves. Very likely, we have what you require in our warehouse right now. For samples or more information, call your Cambridge Field Engineer...he's listed in the yellow pages under "Wire Cloth". Or, write for FREE 94-PAGE CATALOG.

The Cambridge Wire Cloth Co.

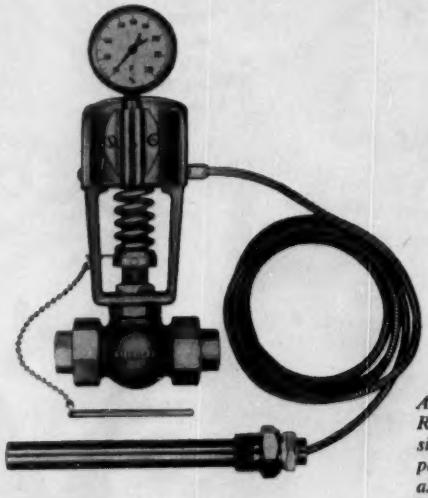
Department G • Cambridge 4, Md.

Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications



immediate

AMERICAN TEMPERATURE REGULATORS begin corrective action with less than 1/10 degree change at the bulb



American Temperature Regulators are made in sizes ½" to 4". Temperature ranges as low as minus 15° F. to 50° F.—as high as 240° F. to 350° F.

response

You get fastest possible temperature response from these new regulators because the stem cannot bind and retard valve action.

The valve stem on American Temperature Regulators is sealed off by a friction-free bellows that makes practical a nonleaking packless valve. Also contributing to fast, stable action is the use of an extra-long preflexed adjusting spring. This spring permits a long range of temperature adjustment without disturbing valve sensitivity at normal levels.

There are other high-quality features in American Temperature Regulators: maximum use of stainless steel; standardized parts; the fewest possible components; and unitized assembly. In addition, compactness simplifies installation in "tight" locations.

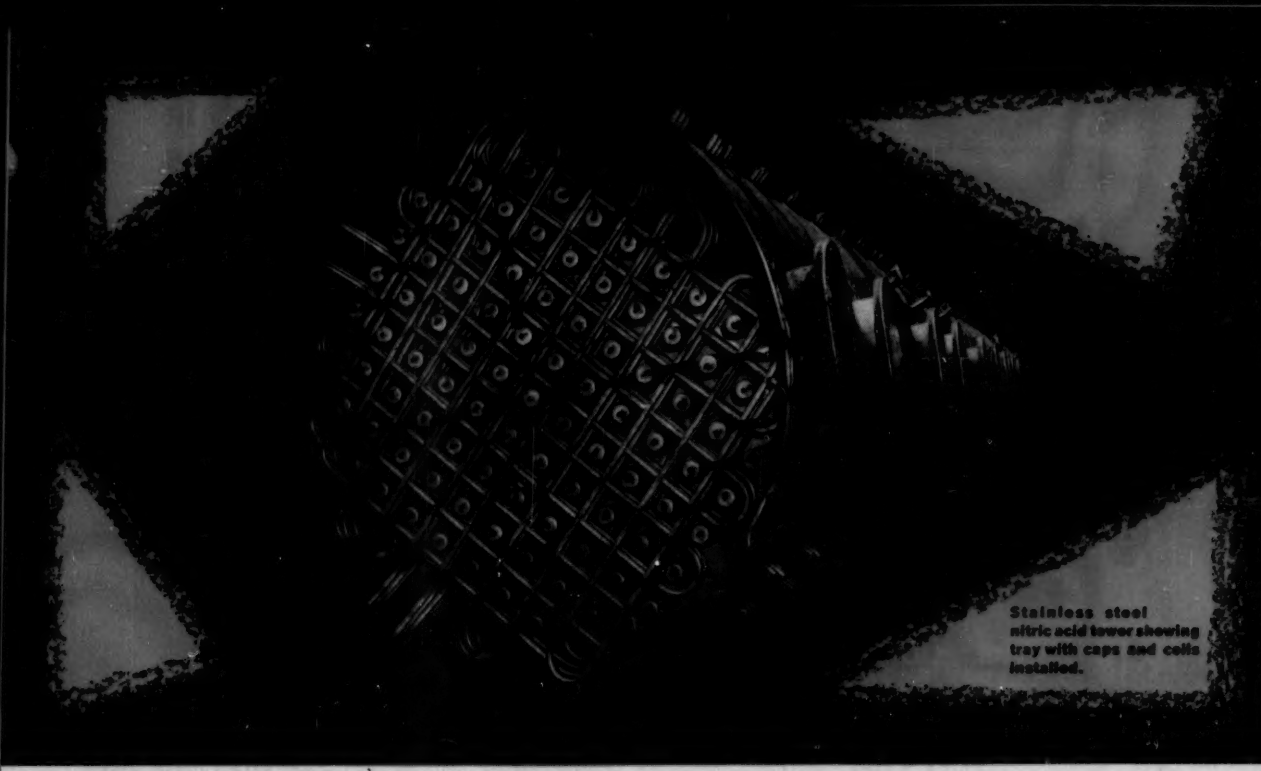
Accurate temperature regulation and attention-free operation mean long-term economy. Your industrial supply distributor will gladly help you select the right American Temperature Regulators for your needs. Write for Bulletin 114A.

AMERICAN TEMPERATURE REGULATORS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario



Stainless steel nitric acid tower showing tray with caps and coils installed.

STRUTHERS WELLS ENGINEERED EQUIPMENT

serves the nation's leading processing industries

Towering almost seven stories, this Krystal crystallizer produces premium grade ammonium sulfate.

Whether you require standard or specialized processing equipment, it pays to select the latest designs. Here are a few examples from today's modern, diversified product line designed and fabricated by Struthers Wells. The results, again and again, have been improved product, increased production and lower overall costs. Your company may also benefit by taking advantage of Struthers Wells' more than 100 years of experience in the engineering and manufacturing of process equipment.

For additional information and address of your local Struthers Wells representative, see Chemical Engineering Catalog, pages 1541 to 1560.

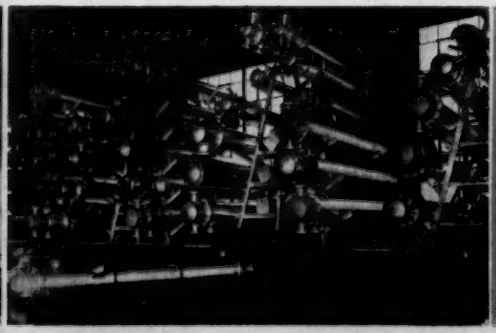
Struthers Wells

Struthers Wells Corporation

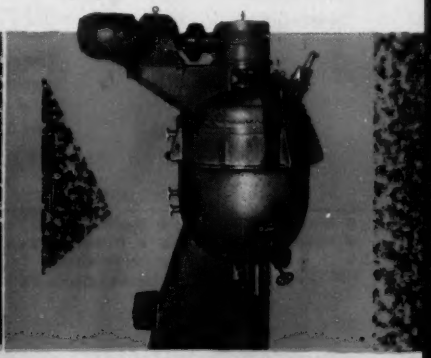
WARREN, PA. Plants at Warren and Titusville, Pa.

Divisions in PROCESSING . . . BOILER . . . AND FORGE EQUIPMENT

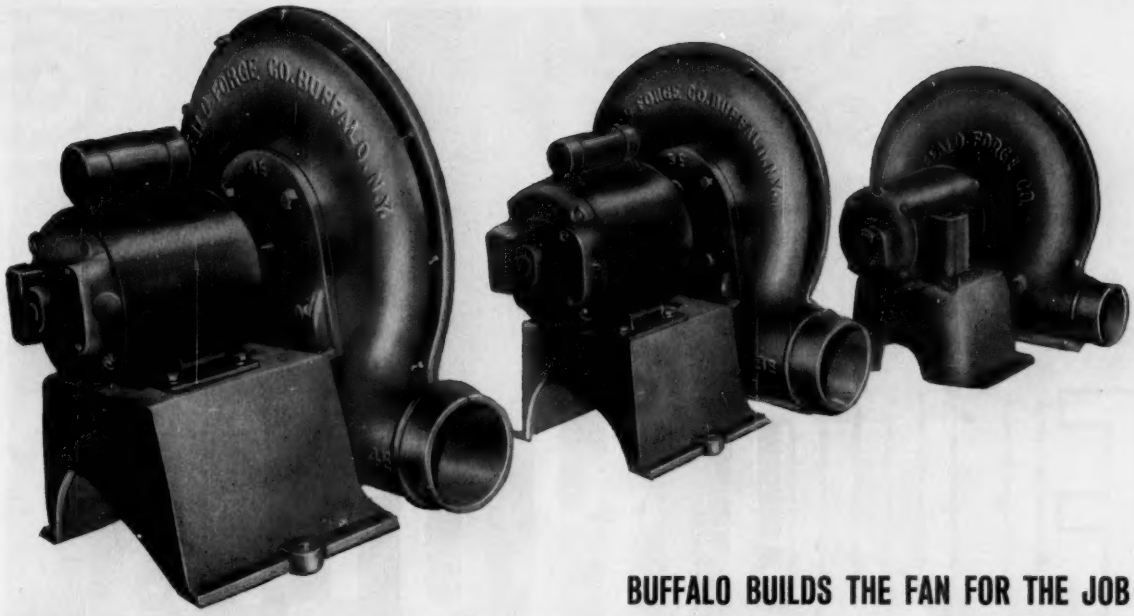
Four heaters, temperatures to 1450°F., serve Texas petrochemical plant.



Standardized heat exchangers available in sizes to 1200 square feet.



"Multi-Action" mixer with specially designed radial propeller.



BUFFALO BUILDS THE FAN FOR THE JOB

BLOWING • EXHAUSTING

FOR PRESSURIZED AIR APPLICATIONS Buffalo Type "E" Blowers are compact, husky units in 5 sizes up to 5500 cfm, for constant pressures up to 2 lbs., on direct-connected applications such as:

- Oil or gas furnace blowing
- Cupola blowing
- Gas line boosting
- Exhausting from grinding wheels
- A quality unit to put on equipment you sell.

A number of these efficient motor-driven units can provide power and installation savings over one large blower — plus flexibility of operation. For full details, write for Bulletin FM-900.

FOR EXHAUSTING AIR OR MATERIALS Buffalo Industrial Exhausters are ruggedly built to handle the most punishing air or materials handling jobs. Their heavy steel plate housing is welded throughout. Wheels and blades are all-welded. Available in designs with heat slinger for moving hot gases (200° to 850° F.) — for handling corrosive fumes — or for moving abrasive or stringy materials such as emery dust, chips and shavings. Write for Bulletin FI-110 or consult your nearby Buffalo Engineering Representative about the complete line of Buffalo Fans for every air job in industry.

BUFFALO FORGE COMPANY BUFFALO, NEW YORK

Buffalo Pumps Division • Buffalo, N. Y.

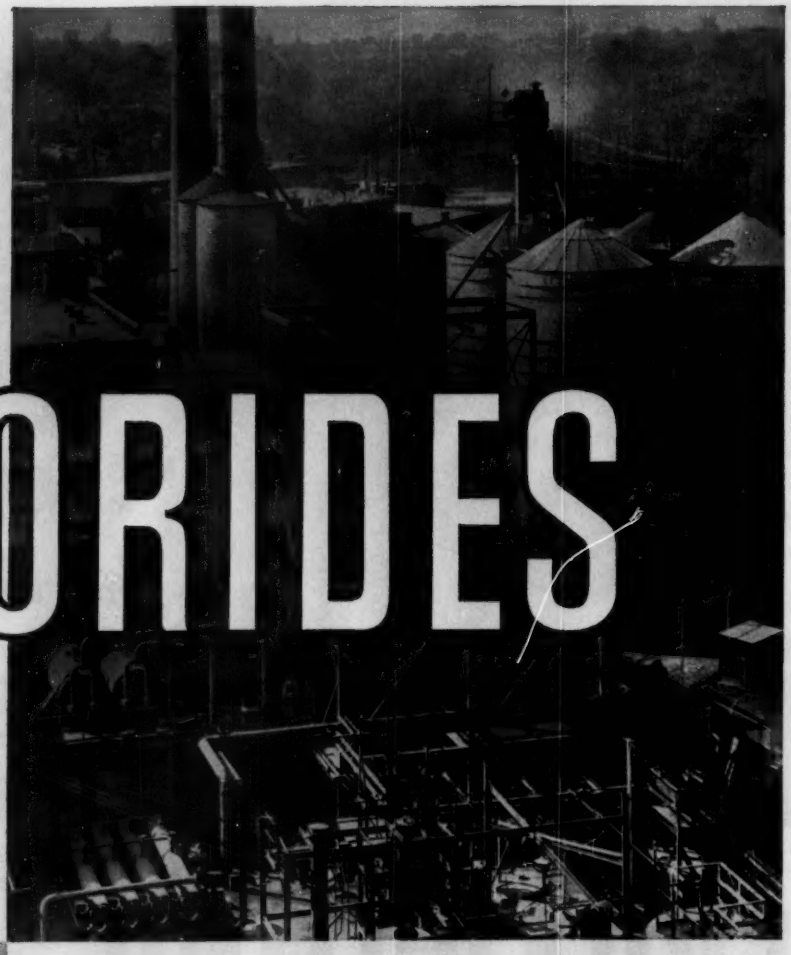
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

HARSHAW

FLUORIDES



Unloading mineral fluospar which comes to us from various parts of the world.

SILICON TETRAFLUORIDE

ANOTHER FIRST FOR HARSHAW

Harshaw's newest fluoride is silicon tetrafluoride. One of the major oil companies has just developed a process for sealing water out of oil wells during drilling with this newly introduced fluoride.

In 1904 when The Harshaw Chemical Co. first started to manufacture hydrofluoric acid, all of the production was used by foundries to remove sand from iron castings. Today, Harshaw's fluoride division produces 26 different fluoride chemicals for as many industries.

The major uses of Harshaw Fluorides are in the petroleum, glass, steel, and atomic energy industries. Even in these industries the uses are diversified. The versatility of Harshaw fluorides is also evident by their use in soldering fluxes, cleaning boilers, removing iron stains and souring laundry, curing plastics, alloying aluminum, floating minerals, sanitizing breweries, and treating water.

HARSHAW'S MANUFACTURED PRODUCTS INCLUDE:

CATALYSTS
CERAMIC COLORS
DYES & FINE ORGANIC CHEMICALS
FLUORIDES
METALLIC SOAPS & SALTS
SYNTHETIC OPTICAL CRYSTALS
PIGMENTS
PLATING CHEMICALS
PLASTIC STABILIZERS

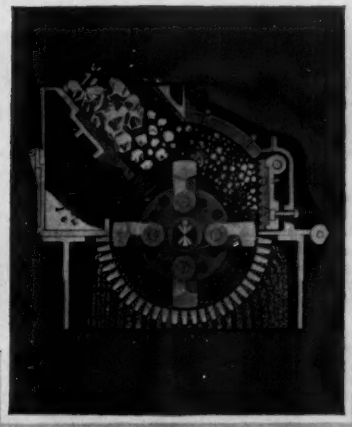
The Harshaw Chemical Company

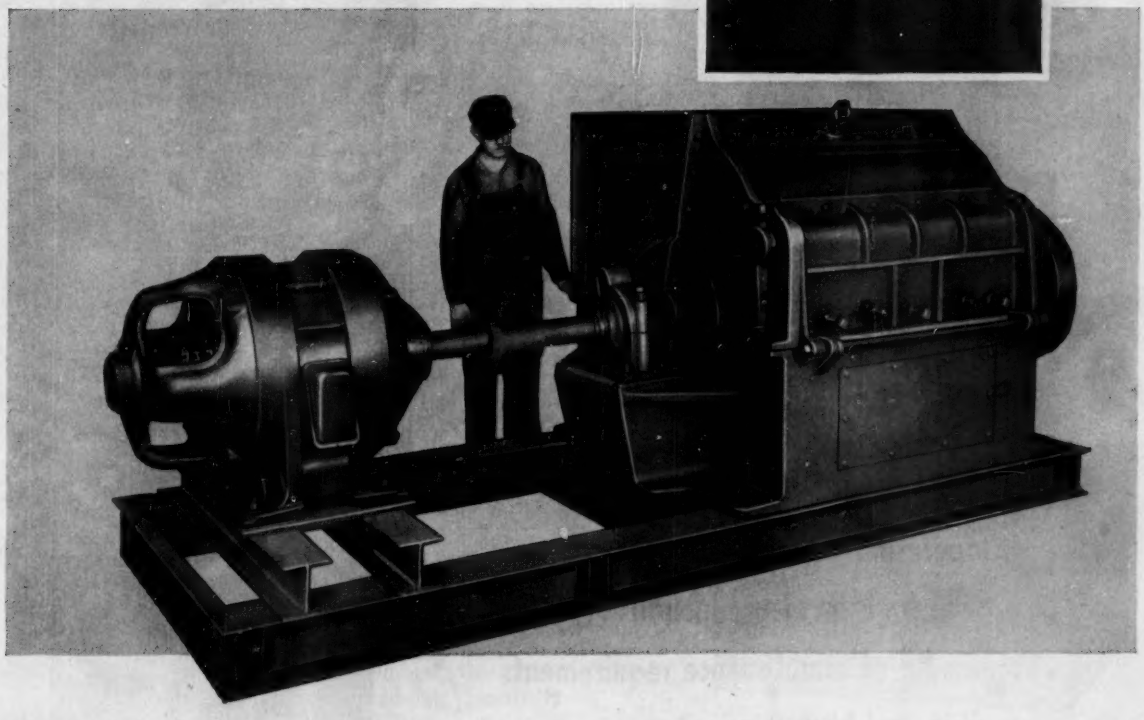
1945 EAST 97TH STREET • CLEVELAND 6, OHIO

HARSHAW'S 5 MANUFACTURING PLANTS

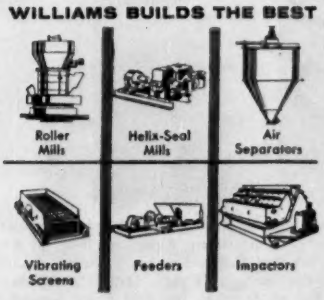
Cleveland, Ohio • Elyria, Ohio • Gloucester City, N.J.
Hastings-On-Hudson, N.Y. • Louisville, Ky.

Complete size reduction... from start to finished product... in a single Williams Hammer Mill





Cut costs as much as 50% on production... up to 75% on equipment



In all normal crushing operations, a Williams heavy duty hammer mill can take most material and, *in a single pass*, reduce it to finished size! Production economies alone, in labor, power, maintenance, as well as stepped up output of better quality and more uniform products, will *cut costs up to 50%*.

Savings in original installations, *as high as 75%*, can also be expected. By making primary and secondary crushers unnecessary, a Williams hammer mill will eliminate all extra conveyors, drives, other equipment, special foundations and additional housing.

Williams hammer mills are built for daily rough and rugged service. Extra heavy manganese steel liners and breaker plates, oversize shafts, massive parts and reinforcements, all defy shock and wear, reduce downtime and replacements to nil.

If the cost price squeeze is one of your problems, get the facts about Williams hammer mills. *Write now for catalog.*

WILLIAMS
CRUSHERS GRINDERS SHREDDERS
Oldest and Largest Manufacturers of Hammer Mills in the World

PATENT CRUSHER & PULVERIZER CO.
2706 N. 9th St. St. Louis 6, Mo.

CREATIVE ENGINEERING TRANSLATED INTO PRACTICAL PRODUCTION

SARGENT imaginative engineering has created numerous "firsts" that are now standard in many industries . . . better drying equipment and methods for better production and better products at less cost.

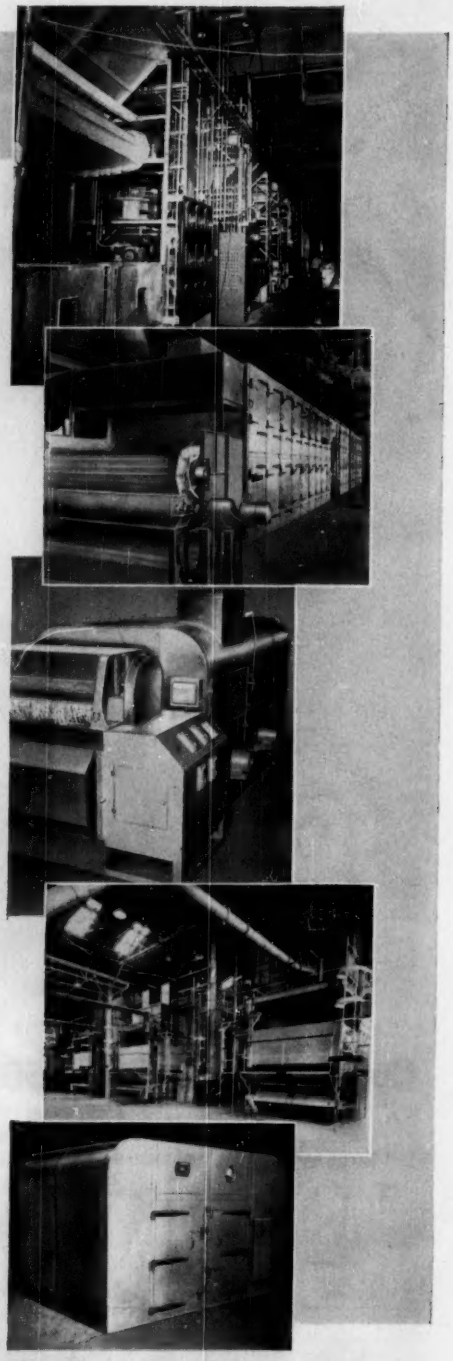
The first gas-fired rubber dryer was a Sargent. The first flashless powder was dried in a Sargent. The first gas-fired conveyor dryers for tobacco, for grain, for wool stock, all were Sargents. New man-made textile fibres and innumerable other products have come to the market dried by special-design Sargents that were designed, engineered and built to the exacting needs of product and of production.

From small lab and table models, from tray and truck dryers, through huge capacity, multi section, multi-stage conveyor dryers and rotary dryers, a Sargent is engineered to serve profitably and well for many years to come.

DRYERS *by* SARGENT Lead The Field

- in operating economy
- proven high-level production
- minimum of maintenance requirements
- easiest, quickest cleanout
- dependability of guaranteed performance
- fastest installation, with erection costs the lowest on the market

Let us give you details.



Sargent installations pictured above: Bank of 4 synthetic rubber dryers, 3-pass, gas-fired, at Goodyear Tire and Rubber Company, Houston, Texas • Two-stage Kaolin dryer with Sargent double-hopper extruder, at American Industrial Clays, Sandersville, Ga. • Pilot plant dryer with extruder and cooling sections. Remarkably compact and efficient. At a well-known chemical company • Four Sargent dryers for England's first general purpose (bulk) synthetic rubber plant. Built under Sargent license — installed at International Synthetic Rubber Co., Ltd., Hythe, Southampton • Two-compartment truck dryer with controlled even heat distribution through all trucks, at a large chemical company.

DRYERS (Conveyor, Tray, Truck, Rotary, Pole, Tunnel, Laboratory, Pilot Plant)
COOLERS • FEEDERS • EXTRUDERS • GRANULATORS

C. G. SARGENT'S SONS CORPORATION
Graniteville, SINCE 1852 Massachusetts

PHILADELPHIA • CINCINNATI • ATLANTA • CHARLOTTE • HOUSTON • CHICAGO • DETROIT • TORONTO

Just add water...

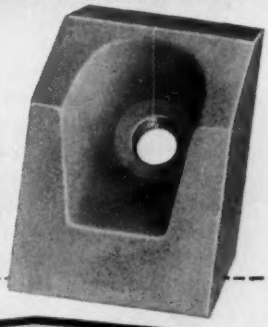
for reliable, low-cost high temperature protection

With Norton ALUNDUM* Castables it's practically that simple and economical to make refractory shapes that would otherwise cost you far more. You make your own molds and, following a few simple directions, mix and pour your own furnace arches, domes, covers, spouts for melting furnaces, etc. Even the most complex shapes can be formed easily and inexpensively. And ALUNDUM Castables are ideal for furnace conditions in all types of atmospheres at temperatures up to 3,300°F.

This versatile castable is available in two types: 1. ALUNDUM 33-I Castable, made up principally of pure fused aluminum oxide *bubbles*. Its light weight and high insulating properties suit it for use in furnace applications subject to high temperature radiation, but mild gas and flame erosion. It is often used as a back-up for ALUNDUM 33-HD material in linings and roof arches. 2. ALUNDUM 33-HD Castable, made up principally of dense, fused *grains* of pure aluminum oxide. It is ideally suited for forming dense, monolithic surfaces where conditions are more severe — provides positive protection against flame impingement and abrasion.

Cut down time for repairs, your inventory of required shapes . . . and save with Norton ALUNDUM Castables. Write for new catalog with complete characteristics and casting instructions. NORTON COMPANY, 503 New Bond Street, Worcester 6, Massachusetts.

*Trade-Mark Reg. U. S. Pat. Off. and foreign countries

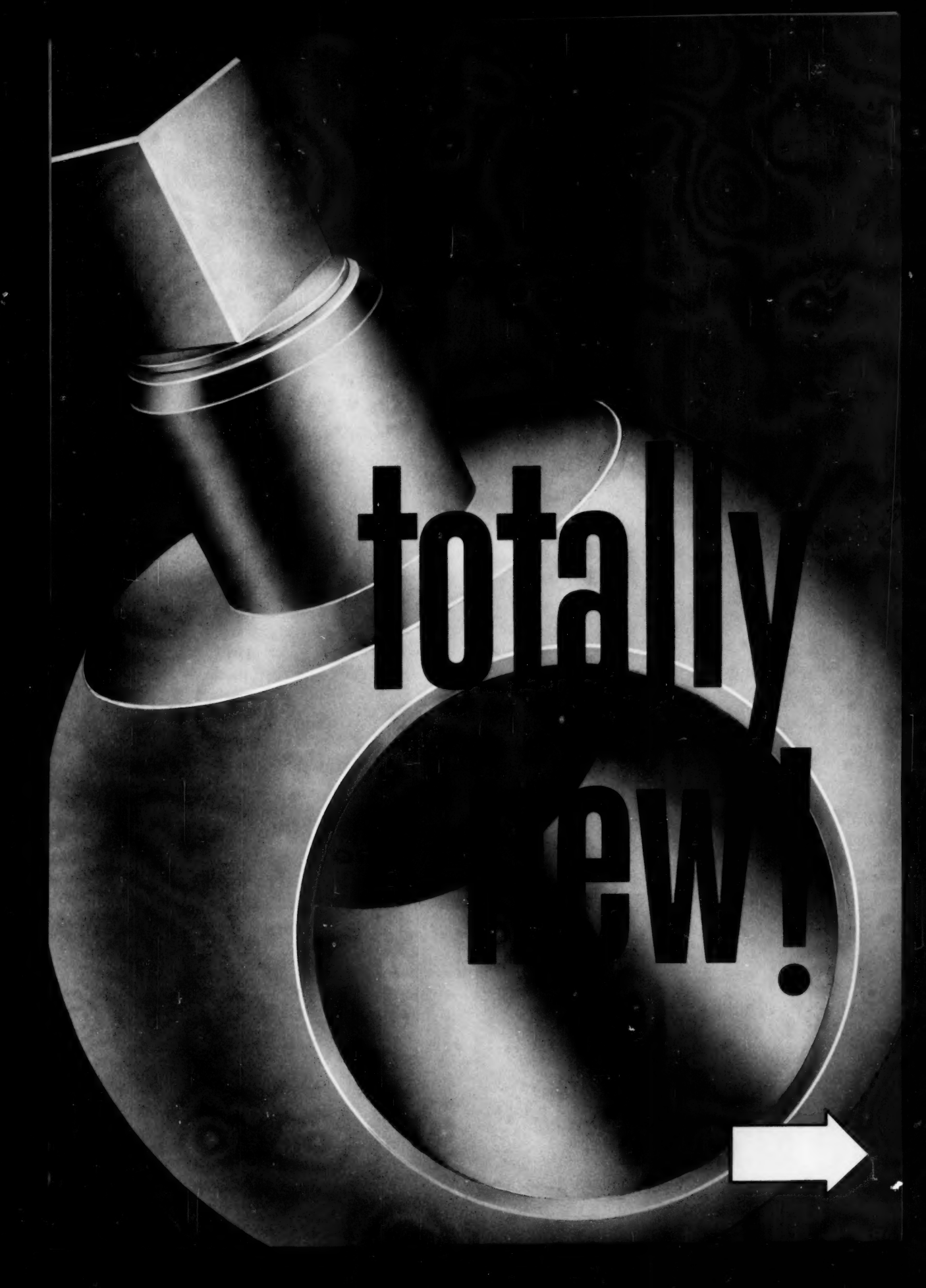


Imagine the savings in making complex shapes like this tapping block right *in your plant.*

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

75 years of . . . Making better products . . . to make your products better

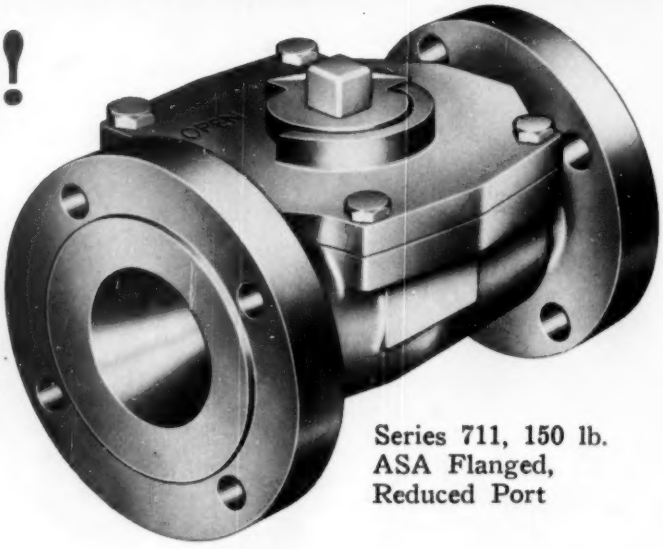
NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes


totally
new!

Only *FLO·BALL* valves are bearing-fixed for maintenance-free long life!

. . . with all the features you must have:

- **Top loading**
- **Replaceable seats**
- **One-piece ball and stem**
- **90° on-off**
- **Two-way flow**



Series 711, 150 lb. ASA Flanged, Reduced Port

Now available . . . the result of years of intensive service in the missile-space industry . . . proven in thousands of adverse applications . . . now at mass produced prices . . . the most advanced line of ball valves ever manufactured . . . for you!

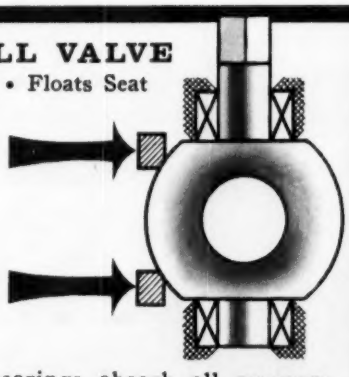
ORDINARY BALL VALVE

Floats Ball • Fixes Seat

Floating ball puts excessive pressure load on fixed seats. Results in distortion and short life.

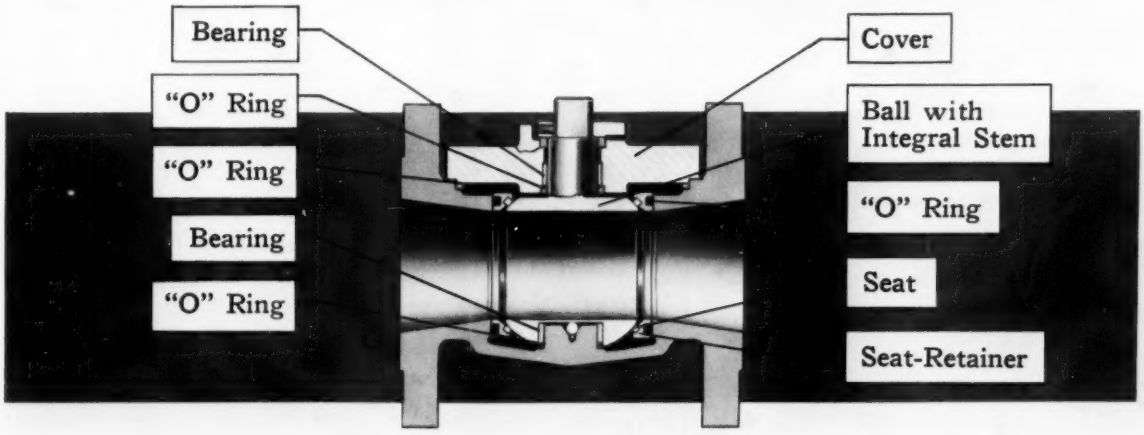
FLO • BALL VALVE

Fixes Ball • Floats Seat



FLO·BALL **bearings absorb all pressure forces. Elimination of excessive seat loading insures long life.**

The Series 711 ***FLO·BALL*** valves are available for off-the-shelf delivery. Manufactured to standard ASA dimensions in carbon steel, 316 stainless steel, and aluminum for body and ball, Teflon for seats, and Buna "N" O-Ring seals. Other materials are also available. These valves operate at pressures to 300 psi, temperatures to 400° F.



The Hydromatics Series 711 FLO•BALL valve gives you the features you must have!

- Bearing-Fixed ball. Engineered to withstand shock and impact without distortion or backlash.
- Top loading. Valve can be disassembled and assembled without removing it from line. No special tools are required.
- Self adjusting, replaceable seats. Both balanced seats are self-aligning and self-adjusting for controlled seat loading and positive seal.
- No lubrication. Operates completely without lubrication.
- Zero leakage. At all operating pressures, including vacuum to 10^{-6} mm. of Hg.
- One-piece stem and ball. Simplified construction adds strength, precision and lower torque.
- Maximum flow efficiency. The open ***FLO·BALL*** valve provides an unrestricted, straight-thru fluid path.
- Lowest torque. Bearing-Fixed construction results in effortless, fast-action with low torque.
- Two-way flow. Exclusive ***FLO·BALL*** seat design principle insures perfect seal in both directions.

Hydromatics, Inc.

FLO-BALL

Mail this postage-free card today

Tear Along This Edge

Gentlemen:
Your Bearing Fixed Flo·Ball valves from ⅛" to 24" may help solve a problem relating to the control of:

☐ Corrosive Liquids ☐ Cryogenic Liquids ☐ Throttling Flow
☐ Vacuum ☐ High Pressure

My flow problem is_____

I now use Ball Valves in these sizes_____

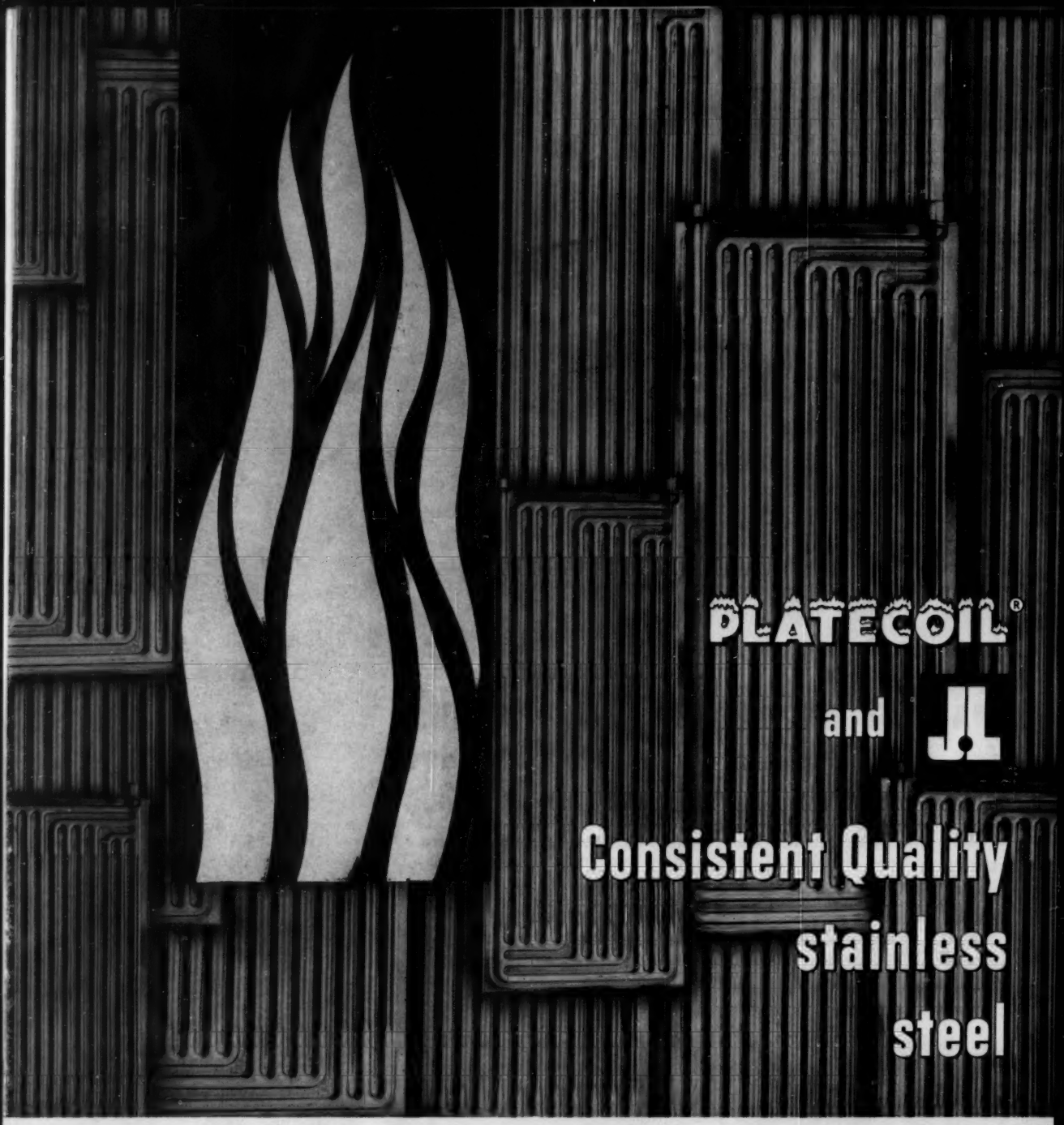
PLEASE: ☐ Have salesman call ☐ Send technical data

My name_____ Position_____

Company name_____

Address_____

City_____ State_____



Maintaining a constant temperature of 70 to 72° F in a 16⅔% sulfuric acid solution is an ideal application for Platecoil... typical of many engineered by Tranter Manufacturing inc., Lansing, Michigan.

Corrosive environments dictate the use of stainless steel, Tranter's rigid production requirements dictate the use of J&L Consistent Quality stainless steel.

Why J&L? Here's the reason given by Mr. M. C. Nolen, Tranter Purchasing Agent:

> "Tranter uses J&L stainless because of its uniform quality. It takes all the headaches out of raw materials and makes our job a matter of just processing this superior product."

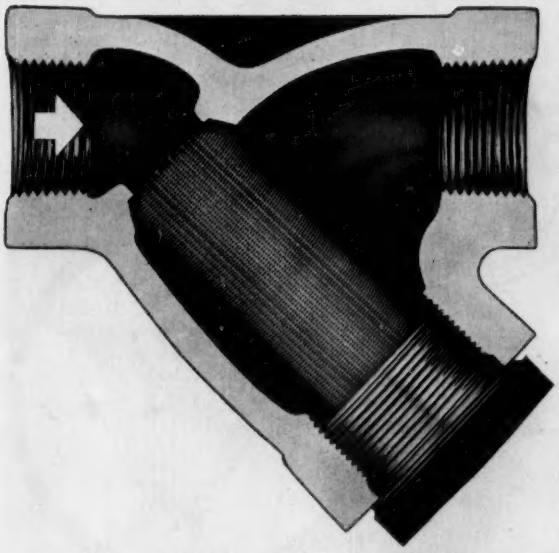
Plants and Service Centers:
Los Angeles • Kenilworth (N. J.) • Youngstown • Louisville (Ohio) • Indianapolis • Detroit

J&L
STAINLESS
SHEET • STRIP • BAR • WIRE

Jones & Laughlin Steel Corporation • STAINLESS and STRIP DIVISION • DETROIT 34

FROM MONEL SCREEN TO PARKERIZED BODY

THEY'RE YARWAY QUALITY



Yarway pipe line strainers are *built for service*—combine more outstanding quality features than any other strainer.

SCREENS are of fine Monel woven wire—sturdy, non-corrosive, long-lasting. Round particle retention size range: .008" to .011". Perforated screens also available. All screens removable and replaceable.

SCREEN CAPS have straight threads, machined faces, spark-plug-type gaskets. Screen comes out with screen cap for easy cleaning. Cap screws back tight without excessive force.

TAPERED SEAT in body, plus straight thread on cap, insure proper alignment, tight fit when screen is replaced after cleaning.

PARKERIZED BODY FINISH, *inside and out,* protects against corrosion.

BODIES on standard strainers are cast iron or steel, screwed, socket-weld or flanged connections. Bronze, stainless steel and aluminum bodies also available.

SIZES and PRESSURES—Screwed, ¼" to 3"; pressures to 600 psi. Socket-weld, ¼" to 3", pressures 600 and 1500 psi. Flanged, ½" to 5", pressures to 600 psi.

For long life, for effective service, you can't buy a better strainer—and Yarways are cheaper in the long run.

Yarway strainers are stocked and sold by the same 270 Industrial Distributors who sell Yarway Impulse Steam Traps; one near you. Write for Bulletin S-205.

YARNALL-WARING COMPANY, 100 Mermaid Ave., Philadelphia 18, Pa.

YARWAY®

FINE SCREEN STRAINERS

Traylor-Made . . . means rugged dependability in heavy machinery. 60 years of industrial engineering experience goes into our ROTARY KILNS, PRIMARY and SECONDARY GYRATORY CRUSHERS, JAW CRUSHERS, APRON FEEDERS, BALL MILLS.

write for bulletins, giving complete information.

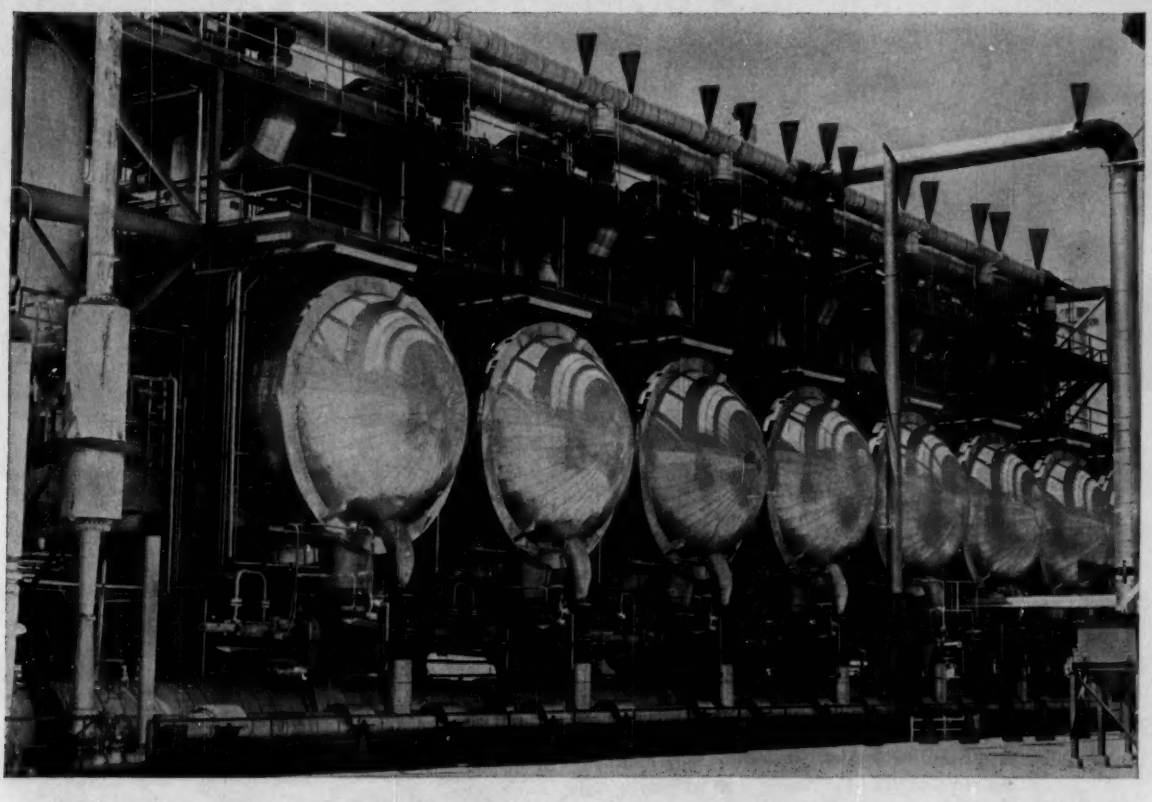
TRAYLOR ENGINEERING & MANUFACTURING
DIVISION OF FULLER COMPANY
1530 MILL STREET, ALLENTOWN, PA.

A121

85½ in. dia. expansion joint connecting quench and pre-quench towers. Pinned structural ties permit expansion joint to absorb axial and differential vertical movement.

48 in. dia. expansion joint at compressor discharge. Double bellows permit large axial movement. Internal sleeve guide provides for stability, minimum pressure drop.

54 in. dia. hinged expansion joints in loop to pre-quench tower. They absorb 5⅛ in. vertical expansion and 7⅜ in. horizontal expansion due to 1200°F temperature in reactor header.



125 ZALLEA EXPANSION JOINTS, 125 demands for maximum reliability

Expansion joints, specially engineered and designed by Zallea, solve problems of space, heat and flow for Odessa Butadiene Co., Odessa, Texas.

Large-diameter piping (up to 72 in. dia.), with short, straight runs and critical flow conditions, posed new design problems. High temperature operation (1200°F) required minimum loading on sensitive equipment. Open-air construction, with few load carrying members dictated maximum stability of expansion joints with minimum use of external guides and anchors to support pipe weight and resist wind loading.

To solve these problems called for a competent, close-working team of process, piping and structural engineers from Fluor Corp. Ltd., design engineers from Odessa Butadiene Co., and application engineers from Zallea.

Result: A compact, reliable piping-expansion joint system that permitted containment of an efficient, 50,000 ton per year unit in an area whose largest dimension is a few hundred feet.

This is another example of how Zallea experience in handling critical, complex Expansion Joint applications can save time and money. For more facts, call us . . . or write for catalog 56.

ZALLEA BROTHERS, Taylor and Locust Sts., Wilmington 99, Del.

Zallea **FOR MAXIMUM RELIABILITY**

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

Becco Granted Patent On In-Situ Epoxidation Using Ion-Exchange Resins as Catalyst

Becco Chemical Division, Food Machinery and Chemical Corporation, has been granted U.S. Patent No. 2,919,283, covering in-situ epoxidation using ion-exchange resins as the catalyst. The process is an extremely practical and valuable one. As evidence, consider that millions of pounds of epoxy plasticizer have already been produced, using this method, by prominent companies in the industry.

Issuance of this patent is additional evidence of Becco's leadership in the field of epoxidation. (A license to use this process is offered to you by Becco; write for details.)

If **you** have an interest in this area, perhaps Becco's experienced Sales Engineers and research chemists can help you. Write us, outlining your problem. Complete confidence, of course. Address: Department CE-4

FOOD MACHINERY AND CHEMICAL CORPORATION

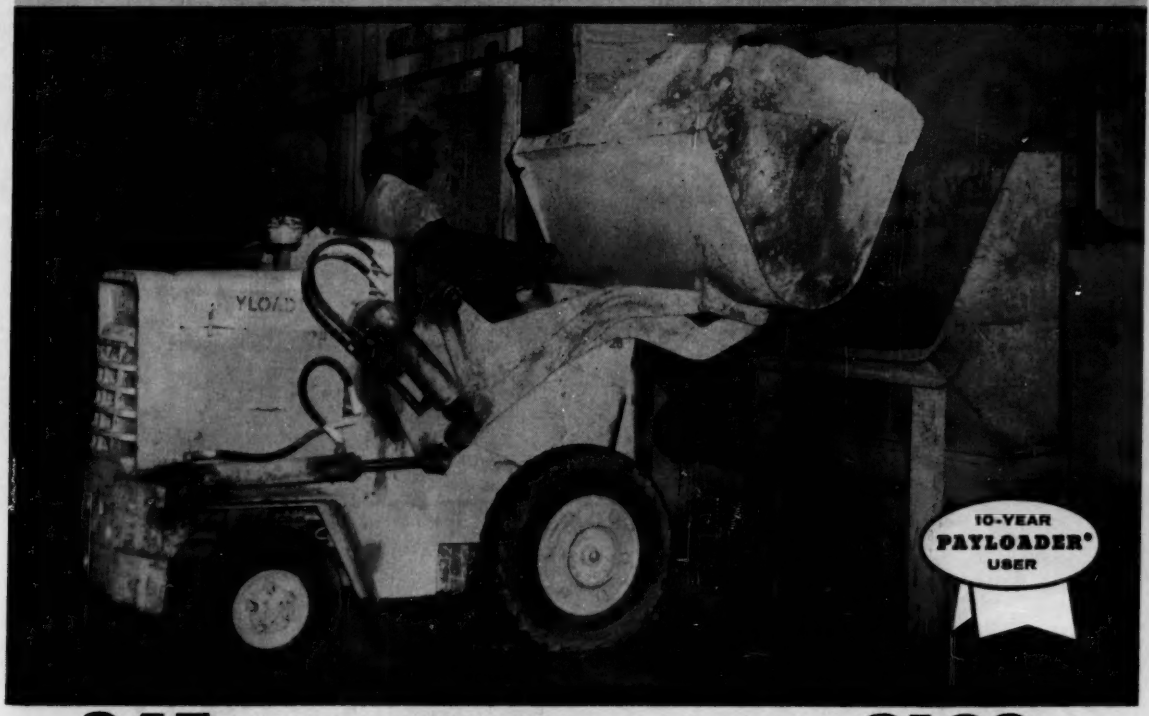
BECCO BECCO

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

BECCO CHEMICAL DIVISION
Food Machinery and Chemical Corporation
Station B, Buffalo 7, New York

PAYLOADER®

PREFERRED BY FLEET OWNERS



245 FLEETS

Among CHEMICAL and FERTILIZER companies in the United States and Canada operating 3 or more "PAYLOADER" units totaling . . .

3102 MACHINES

In addition to the fleet owners, thousands of individual owners have made "PAYLOADER" tractor-shovels the overwhelming favorite throughout all phases of the chemical and fertilizer industries. Fleets ranging as high as 230 machines are proof of owner satisfaction with "PAYLOADER" performance, service and dependability.

Typical of the many fleet owners, is the fertilizer plant of C. ROY CURTIS & SON of Marion, New York, with a fleet of 5 "PAYLOADER" machines dating back to 1950. All 5 machines are still in use. Says Roger Hubright, Plant Supt., "We have been using "PAYLOADER" machines continuously for the past ten years, with very satisfactory all around production and mechanical service. We like the large load carrying capacity of our H-25 with its compact design which enables us to increase hauling output without modifying other plant facilities. H-25 has plenty of power and it's easy to operate."

You too will find a "PAYLOADER" a steady, dependable performer, with many exclusive features which contribute to greater output at lower over-all cost. Choose the exact machine to fit your needs from 20 models. Send for complete details.

HOUGH®

THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
SUBSIDIARY — INTERNATIONAL HARVESTER COMPANY

HOUGH, PAYLOADER, PAYMOVER, PAYLOGGER and PAY are registered trademark names of The Frank G. Hough Co., Libertyville, Ill.

THE FRANK G. HOUGH CO.
754 Sunnyside Avenue, Libertyville, Ill.

Send data on new H-25 "PAYLOADER".

Name

Title

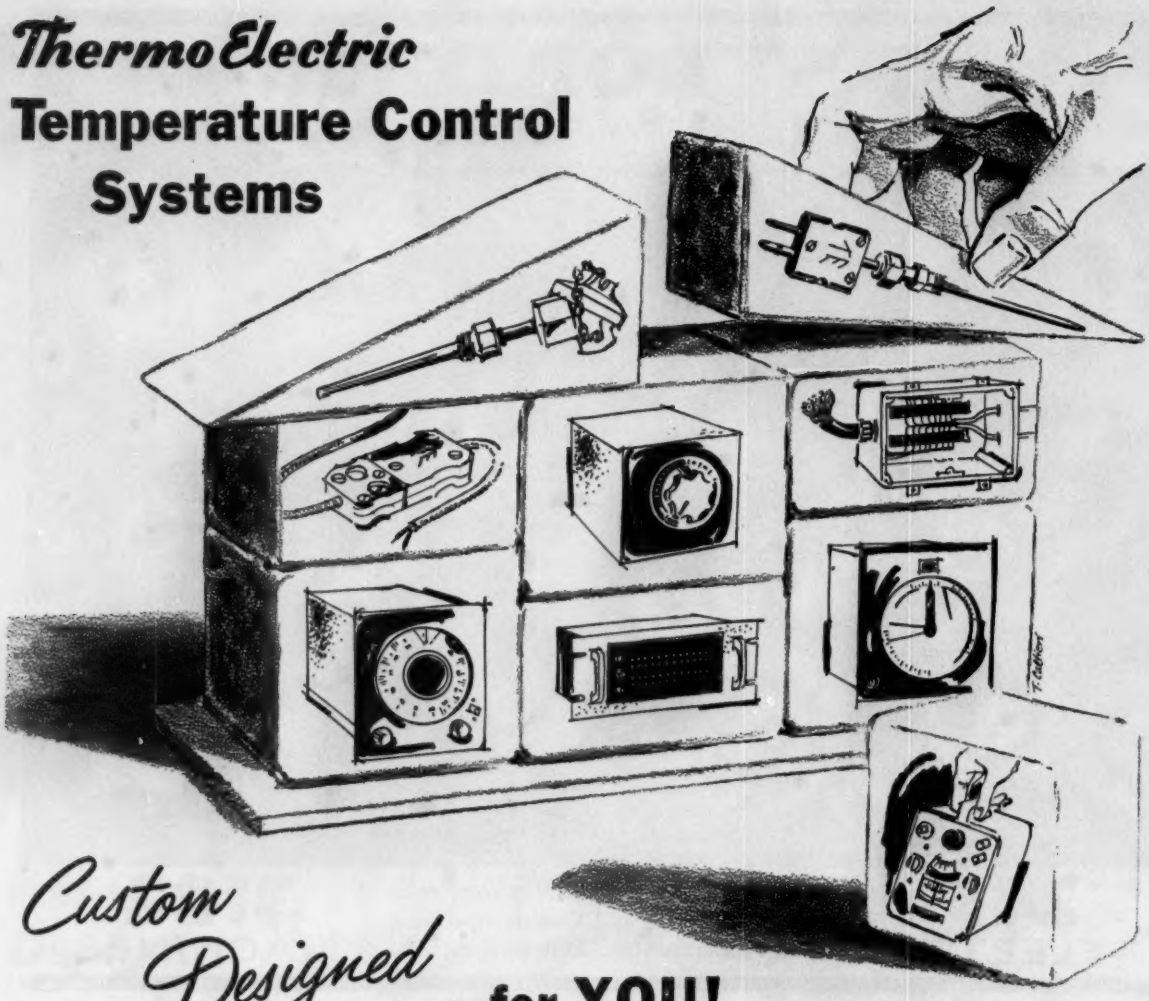
Company

Street

City State

4-A-1

Thermo Electric Temperature Control Systems



Custom Designed — for YOU!

Thermo Electric advanced systems-building components permit custom designing to satisfy your temperature monitoring, indicating, recording, or controlling requirements, exactly and economically. Starting with T. E. thermocouples—standard or special calibrations—from 1 inch to 66 feet and longer, accessories are carefully selected by T. E. applications engineers to relay any number of signals to your instrument panel. Quick-coupling plug and jack connectors and panels, extension wire and cable are precisely matched to eliminate false emf's. Junction boxes, rotary, key or push-button selector switches are all designed and constructed by T. E. to the highest quality standards.

To monitor, indicate, record or control process variables, T. E. offers the compact Signaling Controller—the Indicating Controller and Indicating Recorder with large, easily-read scales, or special multi-point monitor systems. All instruments have front-set controls, complete in-the-field range interchangeability, ease of service, and feature the new High Gain Relay or Servo Amplifiers with high sensitivity and exceptional stability.

The portable "MiniMite" Indicator with 23" scale and 0.25% scale accuracy, can be used to indicate on-the-spot temperature or for calibration and test work.

Let us assist in building your process control system.

Send application details on your letterhead today to Dept. 4

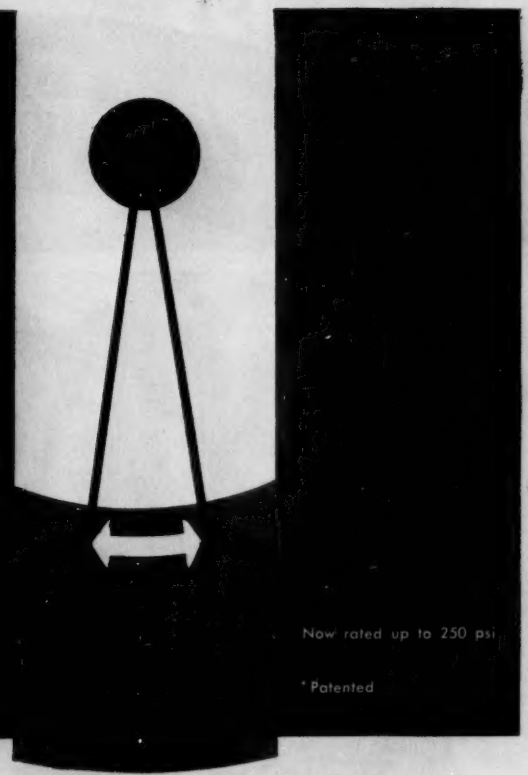
Thermo Electric CO., INC. SADDLE BROOK, NEW JERSEY

In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ontario

MULTI-ZONE

PLATECOIL®

FASTER START-UP, CONSTANT TEMPERATURES

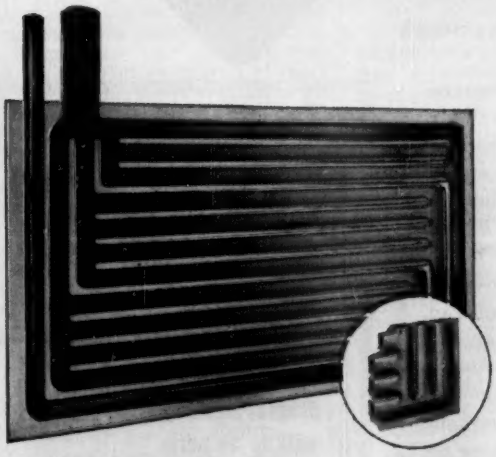


Now rated up to 250 psi

* Patented

The new MULTI-ZONE design cuts "downtime" and compensates for intermittent overload in a wide range of tank and process heating applications. Multiple headers and multiple condensate returns provide for FREE-FLO action — with practically instantaneous distribution of steam to all levels of the plate. Condensate "trapping" is held to a minimum. This gives the new MULTI-ZONE PLATECOIL a reserve capacity to deliver under overload conditions during "start-up." It also produces extremely fast recovery of tank temperature with minimum variation.

IN ALL KINDS OF TANK AND PROCESS HEATING



Operating Pressures up to 250 psi — DURAWELD bonding of the plates and mill-controlled TRANSTEEL in standard units have boosted PLATECOIL pressure containment rating up to 250 psi. This makes the time-proven advantages of PLATECOIL applicable to many types of heating where 250 lb. steam is required. Destruction tests have demonstrated a safety factor of 5 to 1.

Low Installation and Maintenance Costs. — PLATECOIL costs are low compared to the cost of engineering, fabricating, installing and maintaining pipe coils. Lightweight, compact PLATECOIL simplify installation. Greater heat transfer per sq. ft. of surface permits smaller units which save valuable tank space. Streamlined surfaces cut cleaning costs. Integral, factory fabricated construction eliminates threaded joints (in the solution) to corrode or leak. All stainless steel and alloy PLATECOIL units affected by cold working are annealed and pickled after fabrication to return the metal to its original condition and thus eliminate the probability of corrosion due to internal stresses and carbide precipitation.

Write for NEW PLATECOIL Bulletin P61 for more data.

Tranter Manufacturing, Inc.

LANSING 9, MICHIGAN

PLATECOIL® DIVISION

It's the Nash!

The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintain 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. Because there are no internal wearing parts, maintenance is low. Service is assured by a nation-wide network of Engineering Service offices. Write for bulletins now.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature Automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

312 WILSON, SO. NORWALK, CONN.

ECO ENGINEERING NEWS

the big name in small pumps for the process industries

Pumping Notes

•

"Doctor Takes Own Medicine"

Eco GEARCHEM Pump, made of zirconium metal supplied by Carborundum Metals Company, is used in highly corrosive sludge pick-up service at a Carborundum plant. The environment is HCl (3N), H_2SO_4 (3N), H_2SO_4 (5N), methyl isobutyl ketone and 3 normal thio cyanic acid at ambient temperature.

Gears, bearings and packing are du Pont Teflon.

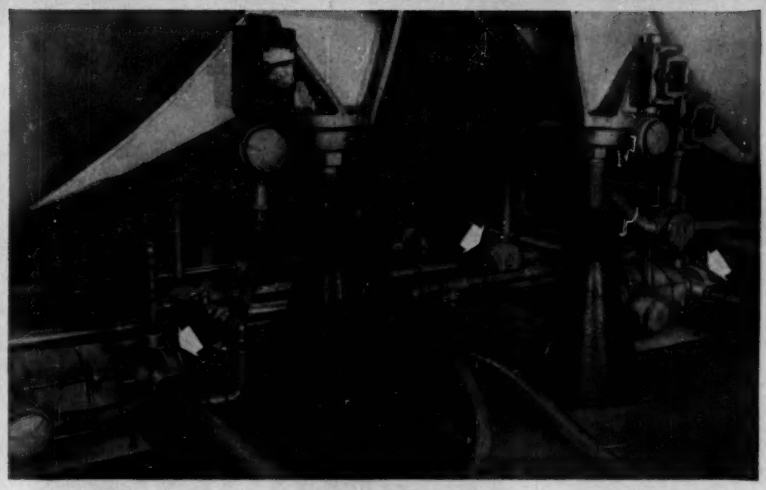
Get Complete Corrosion Data On Zirconium and Titanium

Are you sure that some of your most serious corrosive pumping problems, that stem from high temperatures, pressures and concentrations of reactants, cannot be solved readily with Eco Pumps made from one or the other of these atomic age metals?

A new 8-page Table which gives typical dynamic corrosion resistance values of zirconium and titanium, will help you find out. Write for your free copy.

Ask for Literature on These ECO Products for Handling Corrosive and Hazardous Fluids

ALL-CHEM® Rotary Pumps
MINILAB® Rotary Pumps
GEARCHEM® Gear Pumps
CENTRI-CHEM® Centrifugal Pumps
PUMPMOBILE® Mobile Pump Units
GEAR-VAC® Valves
CHEM-COCK® Safety Drain Valves



Eco CENTRI-CHEM Pumps under storage tanks at Nestle-Le Mur plant. Unique manifold arrangement permits pumping any desired product to various filling stations.

"Nothing Worked Until We Tried CENTRI-CHEM Pumps"

Nestle-Le Mur—originators of the "permanent wave" and producers of many hair beautifying products and other toiletries—had an extremely difficult pumping problem; transferring solvents in which certain gums were dissolved.

Packings Torn to Shreds

Pumps with conventional shaft packings were tried but, on intermittent operation, the gums solidified in the stuffing box when the pumps stopped and the packings were torn to shreds when the pump resumed operation.

Pumps with conventional mechanical seals also gave extremely short service life—at most, a few weeks, before becoming gummed up and inoperative.

Tried Centri-Chem Pumps

Finally the company tried Eco CENTRI-CHEM Pumps and the problem was solved. The rotary seal of these centrifugal pumps refused to gum up and the pumps are giving considerably better than a year's service without repairs of any sort.

Standardized on Centri-Chem

As a result, the company has standardized on Eco CENTRI-CHEM Pumps throughout the plant.

They are used for two principal services: First, product transfer from storage tanks to aerosol can filling machine lines where hair sprays are packaged. In some cases, these filling machines are as far as 300 feet from the storage tanks. Second, feeding filter presses which clarify the bottled products prior to packaging.

Keep Plant Going

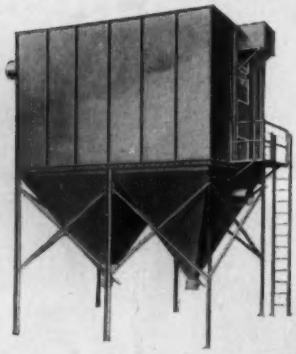
Since both of these services are vital to continuous production lines, it is obvious what disruption to the entire plant's output would be caused by pump failure. Reason why Chief Engineer William Z. Nesin remarks, "life has been almost a pleasure since we installed our CENTRI-CHEM Pumps."

Close-up of one of the CENTRI-CHEM Pumps in product transfer service.

Eco CENTRI-CHEM Pump feeding filter press.

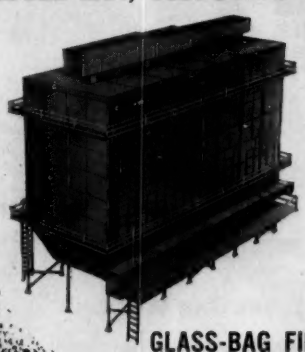
ECO ENGINEERING COMPANY · 12 New York Avenue · NEWARK 1, N.J.

▶freedom from almost any dust



MULTI-BAG FILTERS

▶freedom from hot, corrosive dust



GLASS-BAG FILTERS

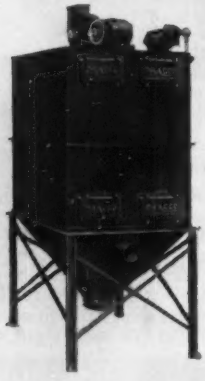
THE NEW PLANT DIMENSION...

freedom from dust

▶freedom from dust thru cyclonic collection

WHIRL-CLONES

▶freedom from small or local dust problems



UNI-FILTERS

BAG-HOUSE COLLECTORS

Dracco can also design, engineer and fabricate bag-house type collectors, where know-how in the application of qualified components is essential.

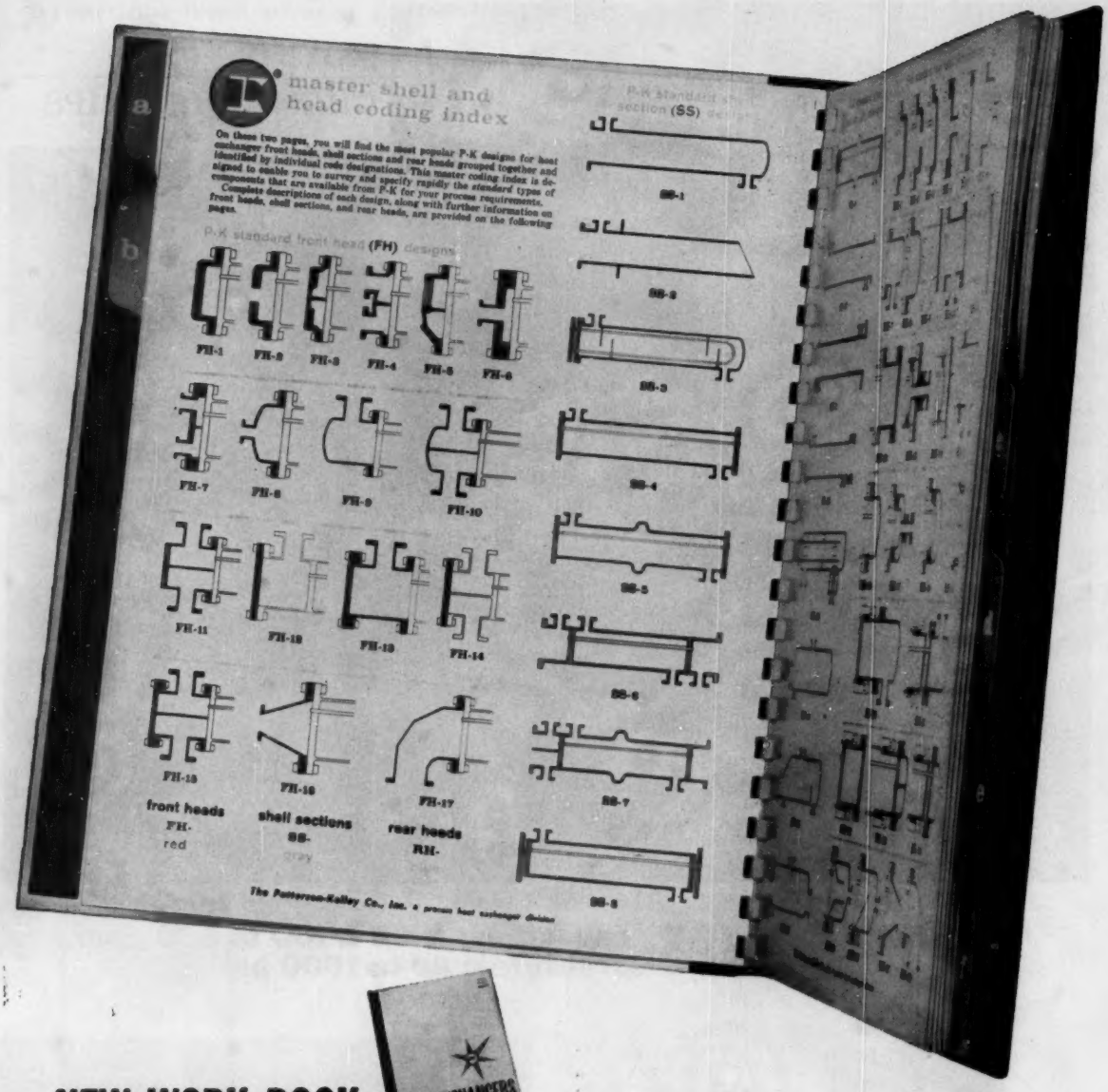
Freedom from dust is a new plant dimension that measures administrative excellence as well as production efficiency.

Advanced manufacturing techniques, coupled with a nation-wide campaign against air pollution, have established need for a new high order of dust control. The Dracco collectors shown here, backed by 40 years experience in dust control engineering, can prove invaluable in your fight for clean plants and clear skies.

A new 28-page brochure "FREEDOM FROM DUST" includes full technical and application data on Dracco's complete line of dry collection equipment. Write Dracco Division of Fuller Co., Harvard Avenue and East 116th Street, Cleveland 5, Ohio.

DRACCO *airstream* conveyors
dust control equipment

FULLER COMPANY CATASAUQUA



NEW WORK BOOK SIMPLIFIES HEAT EXCHANGER SELECTION

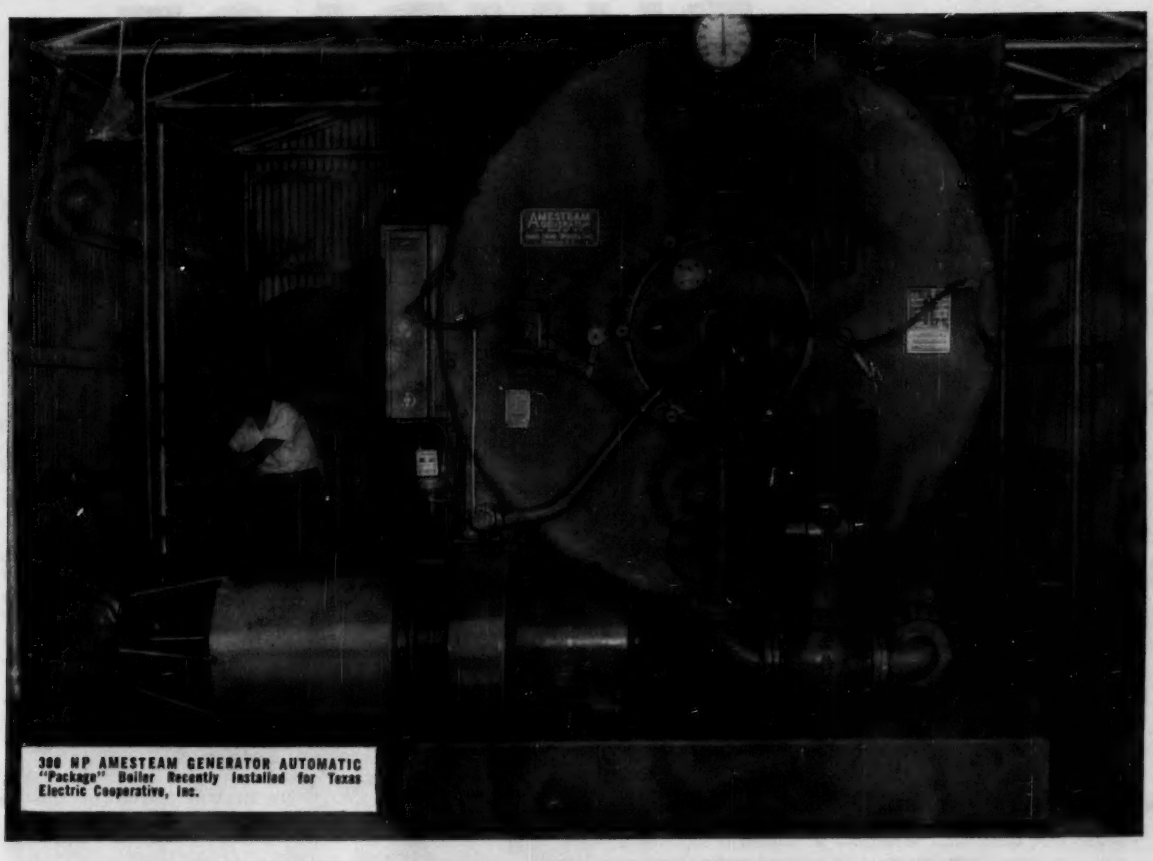
The need for a standard terminology to simplify communications between P-K and engineers in the chemical processing industry has been met in P-K's new Heat Exchanger Manual.

This unique communications tool illustrates and describes components of shell and tube heat exchangers commonly used in processing. A complete system of interchangeable front heads, shells and rear heads is established. Fundamentals of heat transfer and design are reviewed. Even economic considerations are discussed. The simple, certain nomenclature saves time, effort and duplication of engineering work.

This 120-page manual, indexed and bound in hard covers, will be supplemented from time to time with new technical material. Names of holders will be registered to receive such material as it appears.

Only a limited number of copies is available and, naturally, these should go to those in the process industries who will benefit most from the information we have compiled. If you design or specify heat exchangers, write us on your company letterhead, outlining briefly areas of your interest. A few copies are available to students and non-technical personnel at a nominal charge. Patterson-Kelley Co. Inc., E. Stroudsburg, Pa.

Patterson Kelley
Heat Exchanger Division



300 HP AMESTEAM GENERATOR AUTOMATIC "Package" Boiler Recently Installed for Texas Electric Cooperative, Inc.

TEXAS ELECTRIC COOPERATIVE, INC.

Cuts Fuel Consumption Over 36%
Saves Over $15,000 per year
...with AMESTEAM GENERATOR

We Quote the Money-Saving Facts:

"We were very pleased when we replaced two gas-fired boilers in our presssure testing plant with one new 300 HP AMESTEAM GENERATOR Automatic "Package" Boiler. The new Ames unit has reduced our fuel costs alone by 38% ...a saving of *$7,800 per year.*

"Because our new AMESTEAM GENERATOR is entirely automatic, three firemen are now transferred to other duties. This results in an additional saving of *$7,200 per year.*

"This total saving of *$15,000 per year* does not include the considerable savings in maintenance costs. On top of this, the new Ames installation increases our production potential by 20% to 30%... with much higher quality steam."

We at Ames continually receive letters like this from the enthusiastic users of AMESTEAM GENERATORS. Ames customers are *satisfied* customers. They know that when they buy AMESTEAM GENERATORS, they buy LOWER-COST STEAM!

What's **Your** Steam Problem?

If you need 10 to 600 HP and want the kind of space-saving, trouble-free service enjoyed by satisfied users of AMESTEAM GENERATORS, contact your nearby AMESTEAM Dealer or write for our Catalog.

AMES IRON WORKS INC.
BOX S-40, OSWEGO, N. Y.

AMES IRON WORKS
BOX S-40, OSWEGO, N. Y.

Gentlemen:
Please send me further information on AMESTEAM GENERATORS and name of nearest representative.

NAME .....
COMPANY .....
ADDRESS .....

PUMPAGE

Goulds news about pumps for process industries

Glassed pump keeps tattletale gray out of light bulbs

Sylvania Electric Products Co. uses an abrasive slurry of hard fine phosphor particles in a xylol solution to coat the inside of its fluorescent tubes.

This slurry has always been hard to handle. It quickly eroded metal pumps which then contaminated and discolored the slurry. Discoloration increased rejects. A pneumatic system was tried . . . it needed constant monitoring and created a vapor hazard.

Sylvania engineers installed a Goulds-Pfaudler test pump, estimating a nine-month life would pay for the pump. *Over two years later*, the pump shows no wear or foreseeable future problems.

Sylvania now has four Goulds-Pfaudler glassed pumps, each running about 80 hours per week and handling 30 gpm of slurry against a 30-ft. head.

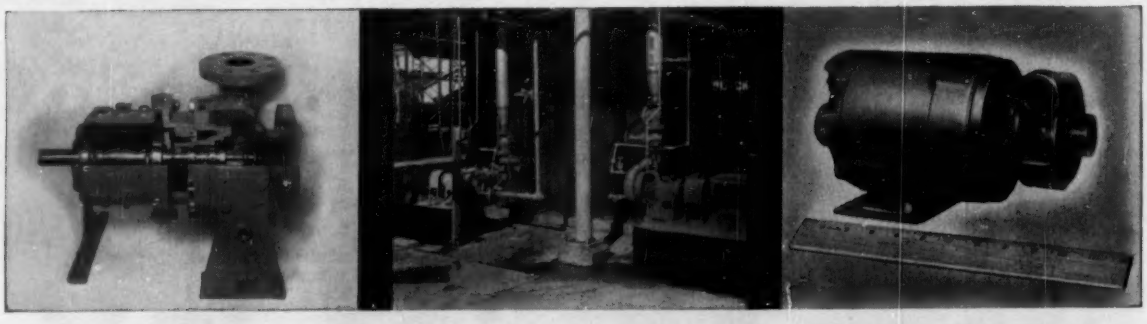
This simple, completely enclosed system ends vapor hazard, involved pipes and controls, and the need for constant monitoring. The inert glass protects product purity.

The ductile iron difference

To make ductile iron, magnesium is added to molten cast iron, changing the sharp, thin graphite flakes to spheroids. The spheroids have large areas of iron matrix between them, and since they have no sharp edges, the ductile iron has far greater strength than the original cast iron.

Ductile iron is so tough it can be used in many applications previously requiring cast steel.

It might pay you to look into this. Write us for information on ductile iron pumps or parts.



Pump with cold feet

The Goulds Model 3775, available in steel and any of the stainlesses, handles temperatures to 600° F because of its cooled support, bearing and seal chamber construction.

It is ideal for handling flammable or otherwise dangerous liquids, withstands thermal shock.

For information on this, or other products on this page, write Goulds Pumps, Inc., Dept. CE-40, Seneca Falls, N. Y.

Vicious viscous kept moving

Over 100 Goulds pumps do a wide variety of pumping jobs at Marathon Southern Corporation.

Among them are two tough 3715's. These keep abrasive, viscous black liquor moving. Each handles 200 gpm to a head of 65 ft. Stainless steel 316 construction resists the bite of hot, abrasive liquor.

Choose construction materials best suited for you when you get the Model 3715. Write for Bulletin 725.4 which lists available materials.

Now...circulate with Hastelloy "C"

If you need a small pump in a hurry to circulate or transfer clear corrosives—we can supply it right off the shelf.

Hastelloy* "C," a highly corrosion-resistant nickel-chrome-molybdenum alloy, is now available on our Model 3604. This ¾" centrifugal pump with big-pump stamina is built for 'round-the-clock service in chemical process work, pilot plant or laboratory.

Drop us a line and we will send you a bulletin with performance chart and other information.

*Trademark of the Haynes-Stellite Division of Union Carbide Corp.

GOULDS PUMPS

SEALING AGAINST SOLVENTS, CRUDE OIL, CRESOL, GASOLINE...

VITON® PACKINGS UNHARMED BY 2 YEARS' FLUID EXPOSURE

With the reputation that VITON synthetic rubber has built for heat resistance (serviceable at 450° F. and up), engineers sometimes overlook the value of its outstanding performance in contact with fuels, oils, solvents and chemicals. Here is an application* where fluid resistance was the *only* problem ... and VITON the only answer.

In 1957, General American Transportation Corporation installed a new fluid loading system at its tank farm in Galena Park, Texas. Swivel joints on the system required packings made of rubber. The problem: what rubber could handle crude oil, solvents, gasolines, cresol and sodium cresylate—to mention just a few of the fluids in storage? The answer: Du Pont VITON.

For well over two years, packings made of VITON, Du Pont's new fluoroelastomer, have been used in General American's tank car loading system to handle more than 80 different fluids. A recent visual inspection revealed no swelling, no deterioration and not a trace of product leakage. What's more, every packing originally installed (72 in all) is still in service.

• • •

Outstanding resistance to oils, fuels, solvents and chemicals, as well as to elevated temperatures, has helped VITON improve performance of refinery valves, heat exchangers, pumps and a wide range of industrial equipment. Write for specific data on the heat and fluid resistance of this new elastomer. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department CE-4, Wilmington 98, Delaware.

*This case history from the ELASTOMERS NOTEBOOK—subscription free on request.

PROPERTIES OF VITON

Hardness Range	60-95 Shore A
Tensile Strength	Over 2,000 psi.
Temperature Range	—40° F. to 600° F.
Chemical Resistance	Excellent
Oil Resistance	Excellent
Compression Set Resistance	Very Good
Ozone Resistance	Outstanding
Flame Resistance	Good
Sunlight and Weather Resistance	Very Good
Abrasion Resistance	Good

DU PONT
REG. U. S. PAT. OFF.

SYNTHETIC RUBBER
NEOPRENE HYPALON® VITON® ADIPRENE®

Better Things for Better Living ... *through Chemistry*

DEVELOPMENTS...

APRIL 4, 1960

Chementator

T. PETER FORBATH

Monsanto has started building a 105% (76% P_2O_5) superphos acid plant at Addyston, Ohio. Product, called Phospholeum, is aimed at uses in metal treatment, catalysts, fertilizers, as dehydrating agent, trace-mineral sequestrant. Because of its high concentration, material offers shipping and handling economies.

Atomic Energy Commission is planning to sink $11 million this year in Project Rover — development of nuclear-powered rocket.

Reichhold Chemical has obtained license to Becco's continuous epoxidation process (Chementator, Nov. 2, 1959, p. 17). Company is already using route to make epoxidized soybean oil, epoxidized fatty acid ester.

New phenol process to go commercial

In the midst of a mounting rush to expand U. S. phenol capacity, Dow Chemical confirms reports that it will use its patented toluene-oxidation flowsheet at its new 36-million-lb./yr. plant at Kalma, Wash., slated on stream by mid-1962.

Toluene route evidently has beaten out the widely used phenol-from-cumene process in a fair fight. Dow previously had purchased an option from Hercules to use the latter's cumene flowsheet but after much study rejected it in favor of the toluene process. Moreover, in way of illustrating how strongly it believes in its choice, Dow has signed a licensing agreement with California Research Corp. in order to avoid any possible infringement hassle with CRC since that company has patents covering a similar process.

Dow's flowsheet involves the oxidation of toluene to benzoic acid, followed by the catalytic conversion of the molten acid, with steam and air, to phenol. Dow's patent specifies cupric ion as the catalyst and temperatures of 220-250 C. Salts of Mg or Co act as promoters to raise yields to about 85%.

Main advantage claimed for this route is the elimination of byproduct acetone. Cumene-based-phenol producers always have to contend with the problem of what to do with extra acetone when they want to expand production. Some industry skeptics maintain, nevertheless, that the toluene process is an expensive way to make phenol.

Technician unions: Threat to engineers?

The National Society of Professional Engineers is intensifying its battle against the unionization of engineers. But its latest move in this campaign has been greeted with a rush of protests—and not only from the dyed-in-the-wool unionists but also from a great many ardent anti-unionists as well.

Stirring the controversy is NSPE's newly

formulated policy, voted by the society's board of directors at its winter meeting in Wichita, Kan., last month, to offer "all possible assistance" in the fight against the unionization of engineering *technicians*. Reason: Unionization of technicians "could hinder engineers in their professional activities and may force professional engineers into collective bargaining units."

To many industry observers, even those with deep-seated anti-engineering-union beliefs, this view is distressingly inconsistent with the classical argument used in opposing the unionization of engineers—including the one formally stated by NSPE. In a nutshell that argument declares, "collective bargaining for professional engineers is in conflict with the basic principles of a professional individual." To be consistent with this basic anti-union premise, contend many observers, it would seem that NSPE can formally concern itself with the unionization of technicians only if it's willing to grant them the same professional status as engineers.

Since this hardly can be the intent of NSPE, a group that has worked long and hard in the cause of raising the professional level of engineering, its new policy takes on the unfortunate character of a pure-and-simple "union busting" device with no connection to the traditional issue of professionalism vs. unionism. For, in essence, what it seems to be saying is that, whether or not unionization is good for the technician, NSPE opposes it because (1) it may make technicians "harder to handle" by their engineer-bosses or (2) it may win such advantages for technicians that engineer-employees working alongside them will find it hard to resist getting unionized themselves.

In either case, feel many observers, NSPE's new policy undermines the argument that unionization is bad for engineers as professionals and unwittingly supports the unionists contention that unionization is only bad for engineers as employers.

Axial compressors gain CPI backers

Though their exact value is still a matter of debate among chemical engineers in many quarters, axial compressors, nevertheless, are beginning to make some notable gains in the chemical process industries. Within the next few months, *CE* has learned, machines of this type, all built by Allis Chalmers, will be installed in an oxygen plant and a nitric acid plant.

• Linde has named two axial compressors to its new 1,000-ton/day high-purity oxygen plant now under construction at Duquesne, Pa., to supply four U. S. Steel mills along the Monongahela River. Units—an eight-stage, 4,350-rpm. machine and a seven-stage, 7,250-rpm. machine hooked in series in a single casing—will compress 125,000 cu.ft./min. of 14.3-psia. air to 98.4 psia. for feed to an air-fractionation column.

• Allied's Nitrogen Div. will replace four aged steam-driven centrifugal compressors with a single five-stage axial at its nitric acid plant in Hopewell, Va. Unit, rated at 3,210 hp., will bring 55,000 cu.ft./min. of atmospheric air to 28 psia. for use in ammonia oxidation.

These moves mark the first major axial installations in the CPI since Texas Butadiene & Chemical pioneered the way in 1957 with six such machines at its butadiene and avgas plant in Channelview, Tex. (*Chem. Eng.*, Oct. 1957, p. 224). What TB&C's experience with the machines has been, is not clear. There have been some rumors making the rounds that the company was having difficulty getting the axials to perform properly in their pioneering service. And for the present, TB&C is offering "no comment."

But whatever the case, axials offer chemical engineers at least one hard-to-ignore attraction: An 8-10% greater operating efficiency than centrifugals. This translates into lower driver horsepower, thus smaller and cheaper motors or turbines, and smaller, cheaper and lighter mounting foundations. Too, it means lower operating costs. And, at the same time, maintenance costs are said to run about equal to those of centrifugals.

ACL kiln wins iron-ore job

Allis-Chalmers-Lepol traveling-grate kiln, with impressive scores chalked up in cement and chemical-lime making (*Chementator*, Nov. 16, 1959, p. 92), has now won a commercial job in iron-ore processing.

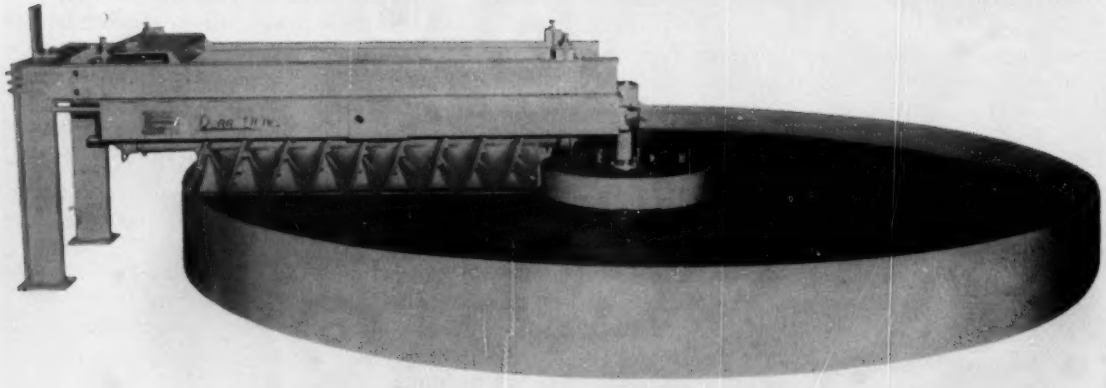
Humboldt Mining (jointly owned by Cleveland-Cliffs Iron and Ford Motor), long eyeing the ACL system in developer-manufacturer Allis Chalmers' Carrollville, Wis., pilot plant, reports it's now installing two 1,000-

(Continued on page 60)

Oliver Horizontal Rotary Filter at Cia. Productora Nacional de Aceites, S.A. plant —an outstanding example of the success of the solvent extraction process for vegetable oil production.

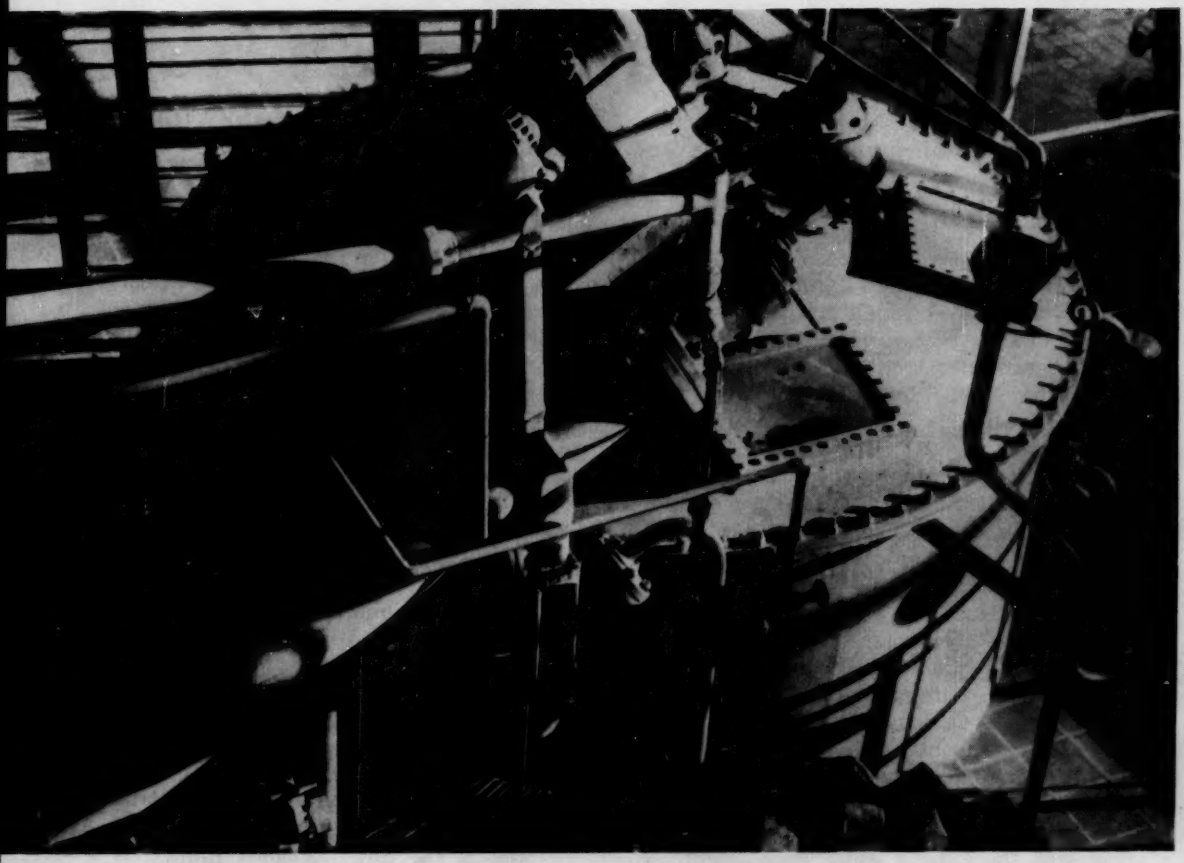
Unique vegetable oil extraction process depends on . . .

OLIVER HORIZONTAL



Oliver Horizontal Filter without cover. Scroll shown is for cake discharge, although paddle wheel or bar flite can be employed.

Filtrex — T. M. Wurster & Sanger, Inc.
Oliver — Reg. T. M. Dorr-Oliver Incorporated



ROTARY FILTER

Up to 99% extraction from sunflower seed meats and rice bran without pressing achieved at plant of Cia. Productora Nacional de Aceites, S.A., Santiago, Chile

The "Filtrex" direct solvent extraction process, commercialized by Wurster & Sanger, Inc., Chicago, Ill., is demonstrating its efficiency in a plant established by Cia. Productora Nacional de Aceites, S.A., Santiago, Chile. Materials handled are sunflower seed meats and rice bran. Extracted oils are refined and used for liquid cooking and salad oil, shortening and margarine.

The major equipment item and key to the simple, economical operation of the Filtrex process is the Oliver Horizontal Rotary Filter. This unit separates the full miscella (vegetable oil-hexane mixture) from the meal solids and counter-currently washes the solids to remove entrained miscella. Arrangements provide for 5 liquid cuts: separation of full miscella from solids, followed by three cuts from progressively lower oil content miscellas, the last wash being oil-free hexane. Extraction efficiency ranges up to 99%. Final oil clarity is such that further filtration is not required.

This application is another example of the adaptability of the Oliver Horizontal Rotary Filter to a wide range of filtration and counter-current washing operations, particularly those involving fibrous and granular materials. For full information, write to Dorr-Oliver Incorporated, Stamford, Connecticut.

DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

ton/day grate kilns at Ishpeming, Mich. Units, to be in operation this spring, will agglomerate and heat-treat hematite flotation concentrates.

Value of grate kilns in this application stems from the nature of the material they're designed to process. A low-grade iron ore found in substantial but, until now, almost unexploitable deposits, hematite must be crushed to a fine powder before its iron oxides can be beneficiated from its impurities. But the powder produced is difficult to ship and, worse, is wastefully blown out of a blast furnace by the normal air draft used in iron making. Neatly whipping these obstacles, the ACL system turns out hard, dense concentrate pellets from beneficiated concentrate powder, so makes processing of these low-grade ores economical.

Each of Humboldt's two units, which will operate in parallel, consists of a refractory-housed, traveling chain-type grate, 9 ft., 4 in. wide on 71-ft. centers, and a rotary kiln, 10 ft. dia. by 120 ft. long. Powdered hematite, raised in iron content to 60% by flotation beneficiation, will be balled in balling drums, screened for ⅜-⅝-in. balls, then fed to the traveling grate. Pre-heated and partially processed there, balls will then discharge to kiln for final processing.

Castro's acts put engineers out of work

The actions of Cuban premier, Fidel Castro, which have worked to the discomfort of not just a few people of late, have now succeeded in disrupting the lives of a large group of American engineers. Because of recent Castro-inspired Cuban legislation, notably that country's new mining law, Freeport Nickel's $119-million, pioneering nickel-cobalt operation (*Chem. Eng.*, Sept. 7, 1959, p. 145) has come to a grinding halt. And, as a result, some 60 engineers, most of them chemical, are out of jobs.

Explains Freeport Nickel's president, Robert Hills, Cuban law has shackled efforts by his company's Cuban-based subsidiary, Moa Bay Mining, to obtain funds with which to complete construction and startup of its plant for producing nickel-cobalt sulfide concentrates. Consequently, last month Moa Bay "regretfully" had to give notice to Cuba's Labor and Agriculture Ministries that it was forced to suspend all its operations. Subsequently, Freeport's own facility at Port Nickel, La., which was to process Moa Bay's output into 50 million lb./yr. nickel and 4.4 million lb./yr., cobalt, also had to shut down.

Bulk of engineers laid off by these events were employed at the Port Nickel plant. Right now Freeport Nickel and its parent, Freeport Sulphur, are making every effort to absorb these men in their organizations, a company spokesman reports. As for the costly complex of nickel-cobalt machinery here and in Cuba, that remains very much at the mercy of the Cuban government. Says Hills, "We have every desire to continue our activities . . . we stand ready to discuss any plans which the Cuban government may develop for resumption of the project."

Reproduce microfilm by dry process

A strikingly unique technique for reproducing microfilm negatives—one that uses no chemicals or wet processing—has been unveiled by small, little-known Kalvar Corp. (New Orleans). And not only has it stirred up quite a flurry on Wall Street,* it has broadened for engineers the utility of microfilm documentation in information retrieval and data processing systems as well.

Key to the process, called Kalfax, is a photographic film developed by Kalvar that consists of a 3-mil-thick Mylar base covered by an unidentified "high-polymer" plastic throughout which are dispersed particles of an ultraviolet-sensitive diazo compound. In its original form film is fully transparent.

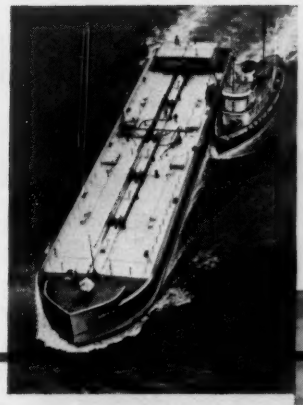
Ultraviolet light is passed through the microfilm negative that's to be reproduced. Upon striking the Kalvar film, the u-v light decomposes the suspended diazo compounds into a colorless dye residue and a gas. Amount of gas generated is directly proportional to the amount of light received which, in turn, is governed by the "figuration" on negative.

Plastic layer of the exposed film is softened by heating to 255 F. This allows gas to escape through the plastic. In so doing, it forms small bubbles and produces a pattern of crystallites on the face of the film that corresponds to the content of the microfilm negative. Pattern is permanently fixed by short-term heating at 110 F. followed by aging.

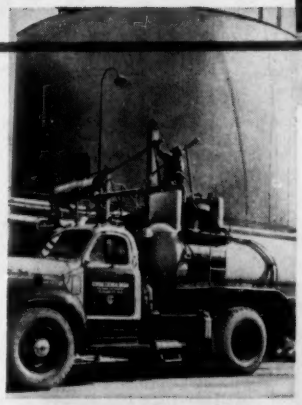
Light projected through the film is scattered by the crystallite pattern, thus makes visible the image it represents. (Kalvar's process is said to be the first photographic

* Kalvar's stock, traded over the counter, rocketed from roughly $52/share in November to about $300/share in March.

To recover spent sulfuric, call on the leader in sulfuric



GENERAL CHEMICAL



Of General Chemical's 21 sulfuric plants, 15 are equipped to handle spent sulfuric! Here are their locations:

Anacortes, Washington
Barnet, British Columbia*
Baton Rouge, Louisiana
Buffalo, New York
Denver, Colorado
East St. Louis, Illinois
Elizabeth, New Jersey
El Segundo (Los Angeles), California
Hegewisch (Chicago), Illinois
Newell, Pennsylvania
North Claymont, Delaware
Port Chicago (San Francisco), California
Richmond (San Francisco), California
River Rouge, Michigan
Valleyfield, Quebec*

*In Canada: Allied Chemical Canada, Ltd.

If you are seeking to recover spent sulfuric acid from your operations and your plant is in the vicinity of any of those listed above, it may pay you to talk to General Chemical.

As the nation's leading sulfuric producer, General has years of experience in recovering many types and strengths of spent acid for its customers. While all cannot be reclaimed, we will be happy to review the economics of recovering yours. As always, the assistance of our technical service staff is readily available to help solve any spent acid handling and disposal problems you may have.

Basic to America's Progress

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N.Y.

technique to use the effect of light scattering rather than light absorption.)

Tomorrow's Technology

Today's embryonic developments which have special significance for chemical engineers

Digging deeper into iron storehouse

M. A. Hanna Co. and U. S. Steel will soon start construction on separate pilot plants in which they'll attempt to develop processes for upgrading low-grade semi-taconite iron ore into acceptable blast-furnace feed. Spur behind these moves: Long-range need to utilize all of dwindling U.S. iron reserves.

Billions of tons of semi-taconite now lie useless in the western end of Minnesota's Mesabi iron range. Though this material is softer and easier to mine and crush than ordinary taconite, it's nonmagnetic and can't be upgraded with conventional processes.

Both pilot units will explore roasting routes to convert nonmagnetic hematite (Fe_2O_3) to magnetite (Fe_3O_4) for magnetic upgrading. Hanna's facility near Cooley, Minn., will cost $2 million, process 10 ton/hr. ore. USS's unit at Coleraine, Minn., will handle 5 tons/hr. ore, utilize propane as fuel for roasting. Company indicates that natural gas, lignite and coal may also be used.

Pickle-liquor recovery at a profit?

Even as one electrolytic pickle-liquor process is being written off as too costly (see p. 68), another one is preparing to make its debut. Ionics, Inc. (Cambridge, Mass.) has come up with a lab-scale route that not only aims at solving steelmen's disposal problems but also claims to show an operating profit.

First step of Ionics' flowsheet borrows the initial step of the well-known Ruthner route (*Chem. Eng.*, Feb. 1956, p. 132). Pickle liquor flows to the Ruthner crystallizer which produces solid ferrous sulfate and H_2SO_4. But instead of converting the $FeSO_4$ to iron oxide as in the Ruthner process, ferrous sulfate is sent to an electrolytic cell. This unit produces metallic iron and an $FeSO_4$-H_2SO_4 solution which feeds back to the crystallizer.

Process key: Design of the three-compartment electrolytic cell. Lead anode chamber contains H_2SO_4 anolyte separated from the middle compartment by a cation membrane which allows H^+ ions to migrate toward the cathode. $FeSO_4$ solution feeds to the catholyte chamber where iron plates out on an iron cathode. To keep a 90% plating efficiency, H^+ ions must be kept from getting into the catholyte chamber. This is done by separating middle chamber from catholyte chamber with a porous asbestos diaphragm. Effluent from the middle chamber is a 50-50 $FeSO_4$-H_2SO_4 solution which is recycled to crystallizer.

Ionics says that a plant handling 40,000 gal./day pickle liquor would recover 50 tons/day H_2SO_4 and 15 tons/day iron. Assuming capital investment of $700,000 with 20%/yr. depreciation and 0.95¢/kwh. electricity, company estimates operating costs at $30/ton H_2SO_4 recovered. Crediting acid at $20/ton, iron at $35/ton and a saving of $7/ton in disposal costs, total credit per ton of acid recovered would be $38—or a profit of $400/day.

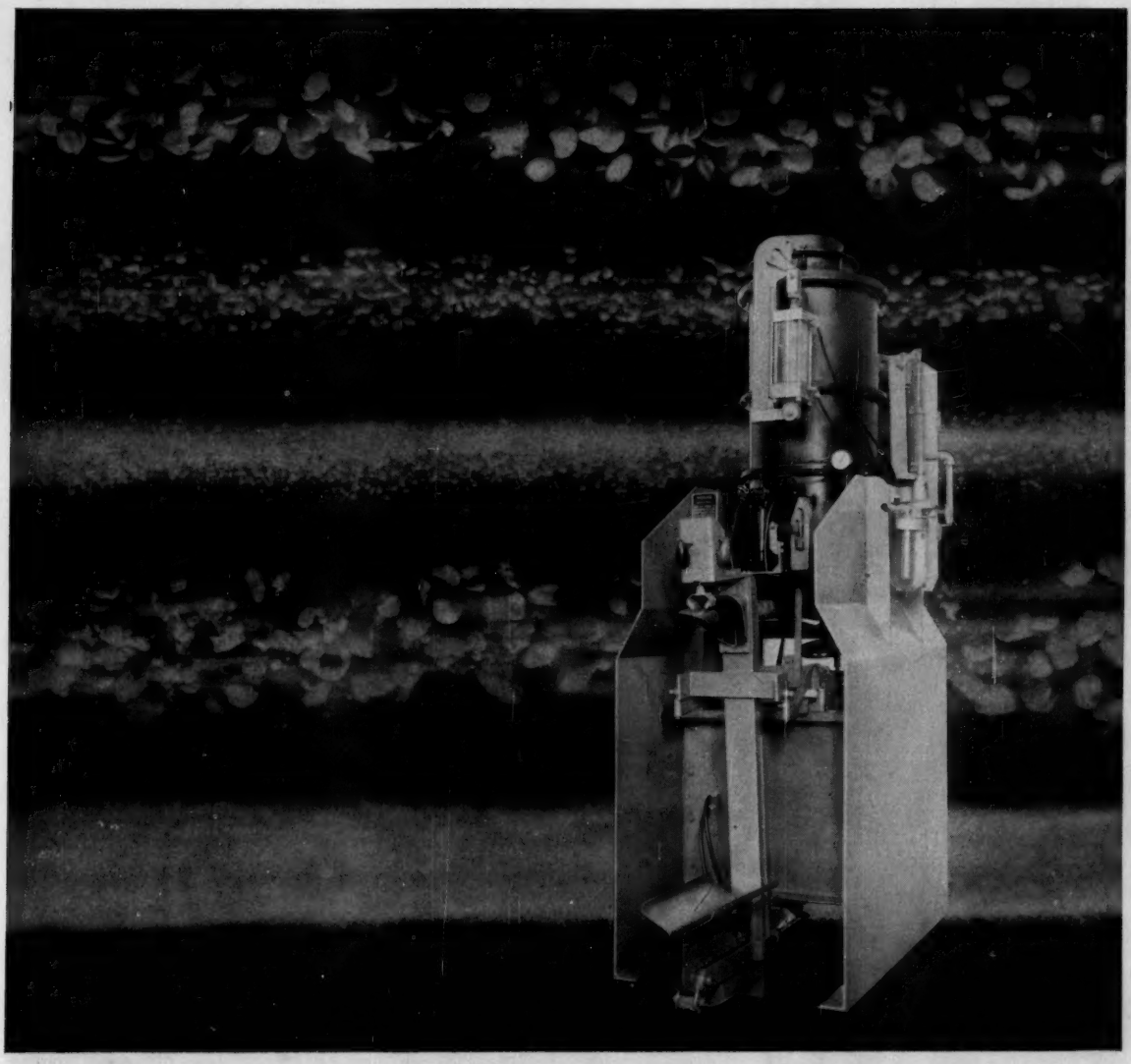
Research and development briefs

Use for depleted uranium is goal of four Bureau of Mines research centers working with Atomic Energy Commission. Several thousands of tons of UF_6 from which fissionable U-235 has been removed is being stockpiled each year. Among prospects: As UO catalyst for shale-oil refining, use with lead, zinc, copper or steel in "superior" alloys, use in sacrificial anodes to combat corrosion.

Nitrogen-fixation enzyme has been isolated from soil bacteria, made to perform its ammonia-making function in labware by Du Pont researchers. Breakthrough may point way to harnessing biological N_2-fixation to commercial chemical processing. Enzyme, identified only as nitrogenase, was extracted from *Clostreidium pasteurianum*, supplied pyruvic acid for fuel.

Uranium monocarbide as atom fuel looks promising, say metallurgists at Battelle. Material can withstand roughly twice as much heat as uranium, possesses more fuel value than equivalent amount of UO_2, can be cast into fuel elements at low cost, seems able to resist radiation damage as well as UO_2. One limitation: Monocarbide corrodes in water, would be unsuitable in water-cooled reactors.

For more on DEVELOPMENTS.....64



The new St. Regis FORCE FLOW* packs anything from granules to powder!

Now *one* machine – the new St. Regis FORCE FLOW PACKER – can be used to pack products with widely different flow characteristics, structure and size. Whether it's powder or granules such as carbon black or fertilizer, this *one* machine will pack them with accurate weights into smaller, cleaner bags.

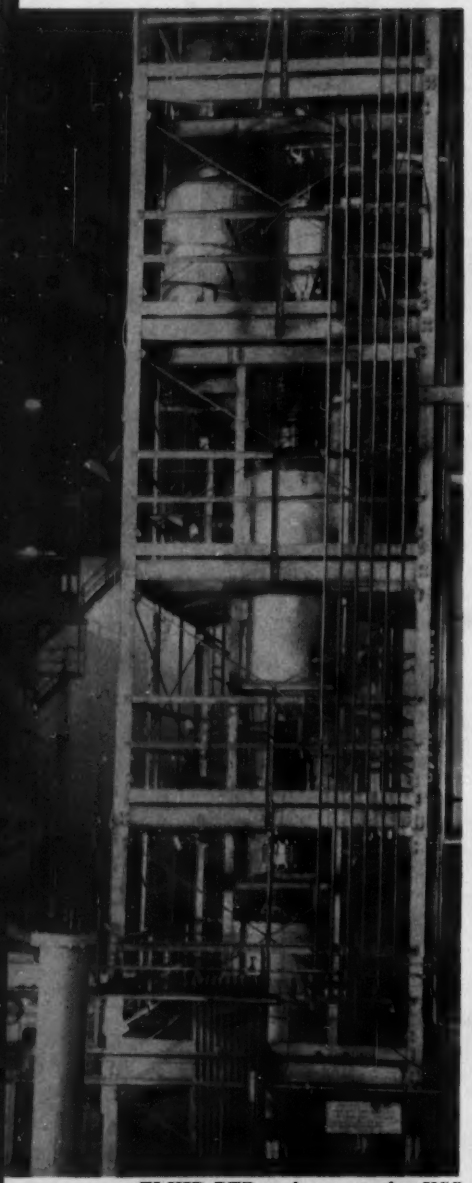
Completely successful during extensive laboratory tests for leading chemical companies, the FORCE FLOW gives every indication of being the "universal packer" long sought by industry. The advantages of this remarkable packer are outstanding: *Reduction in bag size on most products • Excellent weight accuracy • Reduction of dusting and spillage • High bagging rate • Reduction of head room requirements.*

Other special features of the FORCE FLOW PACKER include pneumatic-mechanical controls throughout, plus availability in 1, 2, 3 or 4-tube models.

The FORCE FLOW is another dramatic example of St. Regis Packaging-in-Depth in action.

For free literature write Dept. CE-44, St. Regis Paper Co., 150 East 42nd Street, New York 17, N. Y. Also, see the Force Flow Packer Exhibit at the St. Regis Booth No. 905, AMA Packaging Show. *Trademark

BAG DIVISION St.Regis PAPER COMPANY



FLUID-BED reducer at the USS pilot plant contains two reactors mounted vertically.

Nu-Iron: Good Process, But . . .

U. S. Steel's fluid-bed iron process has licked every problem except that of costs, will aim now for more economies.

U. S. Steel has finally revealed some of the details of the fluid-bed iron reduction process (called Nu-Iron process) that it has been developing for the past six years.* And it differs in some striking respects from the H-Iron process of Hydrocarbon Research and Bethlehem Steel (see *Chem. Eng.*, Feb. 8, 1960, pp. 96-99).

Most interesting of all, however, are USS's conclusions about the economics of fluid-bed direct reduction. Confirming a statement previously published in *CE* (June 29, 1959, p. 42), USS reports that a commercial fluid-bed plant cannot yet compete economically with the blast furnace except under very special circumstances, e.g., in areas where coke is not available.

Despite this conclusion, USS is not shelving the process but is attempting to improve the economics—and is also hoping to find cheaper ways to produce the hydrogen reducing gas.

▶**Reaction Chemistry** — Handling iron powder at high reduction temperatures presents some tricky problems.

Above 1,100 F., reduction rates are fast, but the particles tend to stick together and to the vessel walls. Iron powder produced below 1,100 F. is pyrophoric and decomposes in air. So, USS picked 1,300 F. as the best compromise.

At this high temperature, Fe_3O_4 does not reduce directly to iron but first to FeO. The equilibrium constant for this first reaction is 1.2 and is 0.42 for the second reduction. By contrast, below 1,100 F., reduction appears to go directly to Fe (as in the H-Iron process) with an equilibrium constant down at 0.24 level.

▶**Fit Process to Reaction**—Taking advantage of this two-step reduction, USS designed a two-stage process in which fresh hydrogen reduces FeO in the second stage and the depleted gas then reduces Fe_3O_4 to FeO in the first stage.

Utilizing these two reactions gives a higher H_2 conversion per pass than the one-step Fe_3O_4 reduction, allowing a higher iron throughput and reducing the amount of H_2 that must be recycled.

▶**How It Works**—Nu-Iron process was piloted in a 185-lb./hr. unit at the South Works in Chicago, Ill. This is how it works:

Iron ore is reduced to −10 mesh and is preheated to 1,600 F. in a multi-stage fluid-bed heater. Preheated ore transfers continuously to the top of the first reactor operating at 1,300 F. and 50 psig. where it reduces to FeO. Second reactor then produces 90-95% Fe powder which is briquetted, cooled and sent to storage.

Because of the high utilization of H_2 (32-36% per pass), ratio of recycle gas to makeup hydro-

*Described at the February AIME meeting in New York in a paper authored by T. F. Reed, J. C. Agarwal and E. H. Shipley.

gen is only 2:1. Makeup reducing gas (97-98% H_2) mixes with the purified recycle gas and feeds to the bottom of the second stage. To prevent inerts buildup, a bleed stream amounting to 5-7% of the makeup hydrogen is withdrawn.

Off-gas leaving the top of the first reactor is cleaned by passing through a series of cyclones, a venturi scrubber and entrainment separator. Cleaned gas passes to a direct-contact water cooler which condenses water formed by the ore-reduction reaction.

▶ **The Hardware**—Pilot reactors are two 16.5-in.-dia. stainless steel vessels mounted above one another (see photo) to allow gravity flow of solids. Each reactor is surrounded by a gas-heated chamber to maintain reaction temperature; in a full-scale unit, heat of reaction would be sufficient to maintain temperature.

Bed height is maintained at 5.5 ft. in the first reactor and 12 ft. in the second reactor by position of downcomers. Reducing gas (85% H_2) flows at 6,250 scfh. to maintain a fluidization velocity of 1.5 ft./sec. Feed to the pilot unit is 250 lb./hr. ground iron ore and 1,830 scfh. 97% H_2; output is 184 lb./hr. 90% Fe powder.

▶ **Comments on Operation**—USS says it was able to avoid defluidization and sticking as long as process is controlled within proper temperature and gas velocity ranges. Although these are admittedly narrow, the process is nonetheless controllable and operable.

Economic evaluation of the Nu-Iron process was done on a proposed 2,000-ton/day unit which would utilize two 30-ft. dia. fluid beds in series. Despite the technical success of the process, the present cost of hydrogen makes this route too costly for a country which has blast furnace capacity available.

Interior Dept. Picks Freeze Desalting Route

It's certain now that the fifth —and last—of the Interior Dept.'s water-desalting demonstration plants will use a freezing process. But, as yet, the specific flowsheet, site and capacity of the installation are still to be chosen.

On the latter two points, the best that can be said now is that the plant will be located somewhere on the East Coast and will have an output somewhere between 100,000 and 350,000 gal./day. Construction is expected to get under way later this year.

As for the flowsheet, those of Carrier Corp. (Syracuse, N. Y.) and Blaw-Knox (Pittsburgh, Pa.) are currently running neck and neck in pilot plant evaluations by Interior. Carrier's route in a 15,000-gal./day unit is based on a flash evaporation scheme in which water is partially frozen and partially vaporized out of sea water. Resulting ice crystals are melted to fresh water by heat of condensation released upon compressing flash vapor. Blaw-Knox's approach in a 35,000 gal./day plant involves the evaporation of a hydrocarbon refrigerant in direct contact with pre-cooled sea water. Freshwater ice formed is melted by heat liberated from compressed refrigerant vapor.

The four Interior demonstration plants already named and in the works: (1) 1-million-gal./day long-tube-vertical-distillation plant for sea water at Freeport, Tex., (2) 1-million-gal./day multistage-flash-distillation plant for sea water at Pt. Loma, Calif., using an atomic reactor for its heat source, (3) 250,000-gal./day electrodialysis plant for brackish water at Webster, S. D., and (4) 250,000-gal./day forced-circulation vapor-compression plant for brackish water at Roswell, N. M. Though intended to be firm, this lineup may yet be disturbed by a fight now brewing between Interior and the Navy over the site of the Pt. Loma plant. Navy, whose land it is, is unwilling to transfer the site to Interior, contending that atomic reactor would represent a safety hazard to Navy facilities in the area (e.g., at San Diego). Matter has been referred to the Cabinet.

California Shapes All-Out War on Auto-Derived Smog

California's Gov. Edmund G. Brown is calling for all-out war on auto-derived air pollution. In a special session of the state legislature last month, he recommended this well-armed program for the anti-smog fight:

- Establishment of a state motor-vehicle testing lab, with a fiscal-1960 appropriation of $1.4 million, to evaluate over 20 different auto-exhaust control devices and pick the most effective.
- Legislate that, in the 58 air-pollution-plagued counties of the state, every motor vehicle be required by law to be outfitted with a certified anti-smog device regulating auto exhaust within established standards.
- Empower state and county authorities to subject motor-vehicle owners to fines and imprisonment for failure to install required device.

In a large part, Gov. Brown's program is based on the effective work of the Los Angeles Air Pollution Control District in combating smog-forming emissions from "stationary" sources such as petroleum refineries and gasoline storage tanks. That group, which already has required industry within its jurisdiction to spend some $78 million on smog-control equipment, is said to have eliminated nearly 6,000 tons/day of pollutants from LA-area air.

C. E. Reports on

Latest Developments in Processes

Here is a summary of technical and economic data on process developments that were disclosed at recent national meetings of AIChE, AIME and TAPPI.

Recent developments revealed at AIME meeting indicate that solvent extraction will be expanding its already broad horizons. Current research is tackling such classically difficult separations as cobalt-nickel and the rare earths.

Dow Chemical says it has had laboratory success with the troublesome cobalt-nickel separation using an initial solvent of 10% dinonylnaphthalene sulfonic acid in kerosene. Cobalt and nickel can be extracted from a sulfate feed solution at a solvent loading of about 2 gpl. of each metal.

Both metals are then re-extracted with 20% HCl. Cobalt forms an anion complex in the HCl and can be selectively extracted with an anion exchange solvent (such as a tertiary triisooctyl amine) while uncomplexed nickel cation remains behind.

Cobalt is recovered by stripping with water while nickel is liberated from the HCl by adding H_2SO_4 and distilling off hydrogen chloride.

Dow researcher J. E. Magner emphasizes that no pilot-scale runs have been made and there is no economic data available. He adds, however, that outlook is encouraging because of probable low capital investment and low cost of raw materials. Too, purity of cobalt and nickel fractions is high.

▶**New Rare Earth Process** — Ionics, Inc., has been investigating for Alcoa the possibility of extracting rare earths from bastnaesite using solvent extraction. There are large deposits of this mineral in California and Alcoa has developed a flotation process for concentrating the rare earth fraction. Problem is to separate the rare earths economically.

Ionics' process revolves around three unidentified solvents. Rare earth concentrates dissolve in hot H_2SO_4, then are treated with water and Na_2CO_3 to precipitate rare earth salts.

Redissolving these salts in NaOH and HNO_3 gives a rare earth concentration of 200 gpl. in solution. By converting cerium (50% of total rare earths) to its quadrivalent state, it can be solvent extracted in 99.99% purity.

Heavy rare earths (about 1% of the total) separate out in another solvent extraction leaving lanthanum, neodymium and praseodymium in solution. Another solvent extraction selectively strips out Nd and Pr, leaving La behind in 99% purity.

▶**What Does SX Cost?**—Based on the laboratory results, Ionics made a cost estimate for a plant to turn out a total of 5 tons/day rare earths. Conclusion: It would cost about 71¢/lb. via the solvent extraction route vs. about $7.50/lb. for the conventional ion exchange process (*Chem. Eng.*, July 27, 1959, pp. 104-107).

This large cost difference stems from three factors: capital investment ($2.8 million vs. $16.8 million), cost of resin vs. solvent inventory and the cost of reagents involved. Ion exchange, however, still has the advantage of turning out purer products—and is a commercially proven process.

▶**An Old Standby**—Union Carbide Nuclear has been using the standard uranium solvent—tributyl phosphate—to separate rare earth mixtures that are by-products of nuclear operations. In a 144-stage pulse extraction system, UCN prepared 1 kg. of 95% gadolinium oxide using this solvent.

To extract promethium from nonradioactive fission products, UCN employs a 20-stage cascade system in the first cycle and a 34-stage second cycle to give a 90% Pm yield at 83% purity. With 14 more stages in first cycle, engineers estimate, Pm yield could be increased to 93% with 99% purity.

Recover Acid

Another pickle liquor recovery process has been proved technically feasible but appears headed for cold storage for the same reason that plagues all pickle liquor processes: Economics. The same fate recently fell to the once-heralded Ruthner recovery process.

In a paper given at the AIME meeting in New York in February, Charles Mantell and Luisito Grenni of Newark College of Engineering described a process they were evaluating for "a major steel company." It employs permselective anion exchange membranes to recover sulfuric acid and iron powder from pickle

Latest Developments in Processes (cont.)

liquors. Conclusion: process is technically feasible but costly.

▶ **Membrane Between Electrodes**—Process uses an electrolytic cell with titanium cathode and lead antimony anode, separated by an anion exchange membrane. Spent pickle liquor enters the the catholyte chamber where iron deposits on the cathode and sulfate ions migrate through the membrane. Depleted ferrous sulfate catholyte overflows at the opposite end of the cell to the anolyte compartment where sulfate ions react with water to form H_2SO_4 and oxygen. Overflow from the anolyte chamber is sulfuric acid (with some iron) which can be recycled to the pickling operation.

Based on the results of a 100 gal./hr. unit, Mantell estimates that a plant to treat 41,000 gal./day of pickle liquor would require a capital investment of $2.5 million. And it would show an operating loss of about $1,500 per day, crediting $10/ton for the iron recovered.

Lower Pulping Costs

One new mechanical pulping process was revealed and more data were added to a known, but commercially untried, process at the TAPPI meeting in New York in February. These developments add impetus to the growth of high-yield mechanical hardwood pulping which one observer describes as "the most significant development in the pulp industry in a decade."

The new process is Dorr-Oliver's HiFibre process which is being piloted on a 15-ton/day scale at an unidentified mill.

One feature of the new pulping route is the use of lime instead of more expensive sodium hydroxide, saving an estimated $5-6 per ton of pulp. Too, says Dorr-Oliver, capital costs are about 10% less than conventional cold soda mills and power consumption (10-15 hp.-days/ton pulp) is only about 25% that of conventional units.

Although cold soda can also be used in the HiFibre process, Dorr-Oliver feels that in many instances the cost advantages of lime pulping will outweigh the fact that pulp is not as strong as cold soda pulp.

▶ **Mill Is a Pump**—To impregnate chips with pulping liquor, steeped chips feed into a continuous roller-mill. As cylinder rotates, chips are caught in the nip between the cylinder and the driven rolls, then enter a fog of treating liquor as they leave the nip. This action "sucks" chemical into the chips and readies them for defibering.

After mechanical impregnation, chips at 30-40% consistency fall into another roller-mill with a speed differential between the cylinder and rolls to give compressive and shear action for defibering. Consistency is reduced during defibering by a water shower to wet liberated fibers giving a discharge consistency of 20-25%. After defibering, cold pulp is screened and classified.

▶ **Low Power, High Strength**—The Black Clawson low-power pulping process claims electricity consumption of 9-13 hp.-days/ton of pulp. Process consists of press impregnation of chips with cold soda, then feeding chips at 35% consistency to a two-disk refiner with disks rotating at the same speed and in the same direction. Plates have small pyramid teeth which hold the chips and the centers are offset to give a speed differential at each point which disrupts the bundles into fibers.

Besides the low power consumption of this process, it produces a strong pulp in the softwood groundwood range through proper manipulation of treating, defibering and refining conditions.

High Energy Fuel

When the dust settled around the boron fuel hassle, Callery Chemical wound up with a contract to supply 1,000 lb./day of borane fuels to the Air Force. At the AIChE meeting in Atlanta, Callery revealed a process it had developed for turning out small batches of diborane—but would not say if this process is being used to fill the current AF contract.

Process involves reaction of potassium borohydride and boron trifluoride to give potassium fluoroborate and diborane using diethylene glycol dimethyl ether (diglyme) as a solvent:

$$3\ KBH_4 + 4\ BF_3 \rightarrow 3\ KBF_4 + 2\ B_2H_6$$

To start reaction at Callery's 100 lb./day pilot unit in Callery, Pa., BF_3 is added at 40-50 lb./hr. to 120 lb. of KBH_4 dissolved in 60 gal. of diglyme. After 2 hr., diborane begins to evolve and BF_3 rate is cut back to 20 lb./hr. to keep reaction temperature below 105 F. Diborane vapor passes from reactor through an entrainment trap, then a 14-F. heat exchanger and finally a dry ice cold trap to condense the diglyme solvent.

Two-stage compression brings the diborane up to 125 psig., then it condenses in a heat exchanger at −75 F. and is stored as a liquid. Yield is about 32 lb. per batch. Corrosion is not a serious problem in the process with most of the pipes and vessels made of mild steel.

Ultrahigh Pressure

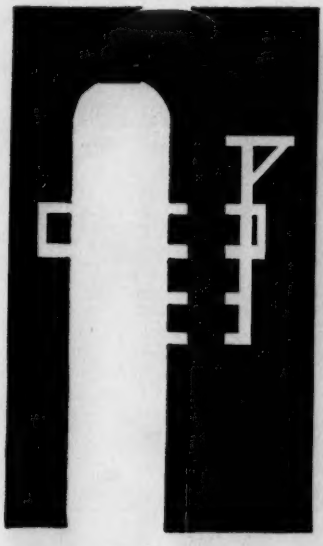
Use of ultrahigh pressures (over 30,000 atm.) as a tool for chemical synthesis holds out the lure of improved abrasives and refractories, new nuclear fuel compounds, stronger plastics and more complex chemicals.

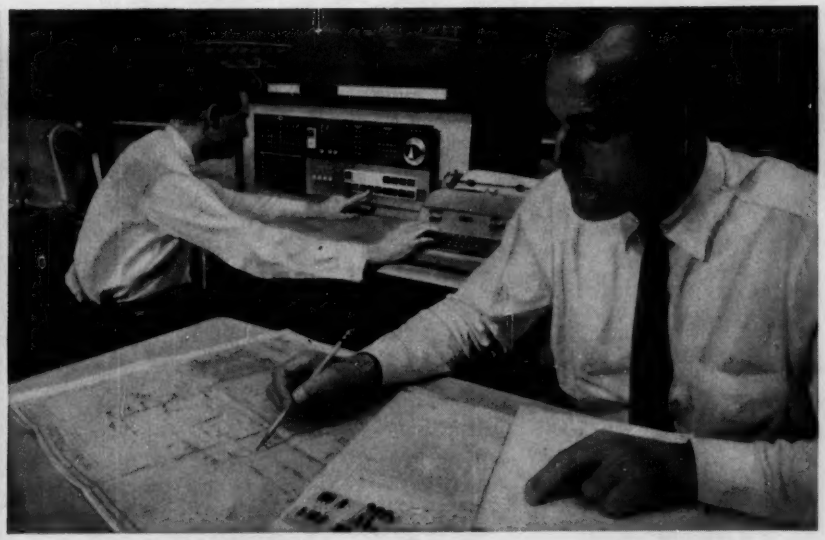
This is the conclusion of C. M. Schwartz of Battelle Memorial Institute where a newly developed device has reached 130,000 atm. in preliminary tests and it is believed it can attain 260,000 atm. at 3,000 C. One practical application of these extreme conditions under investigation is the possibility of stabilizing the fluorite structure of UO_2 against oxidation by the addition of other oxides in solid solution to make a more stable nuclear fuel.

Processes & Technology continues on page 70.

IBM 1620 *data processing system*

...the most powerful engineering computer in its low price class





In the Chemical Industry the IBM 1620 solves problems like these:

- *statistical design of experiments*
- *reactor design*
- *mass spectrometry*
- *kinetics*

The new IBM 1620 is a desk-size engineering computer that offers you more computing ability per dollar than any system in its price class.

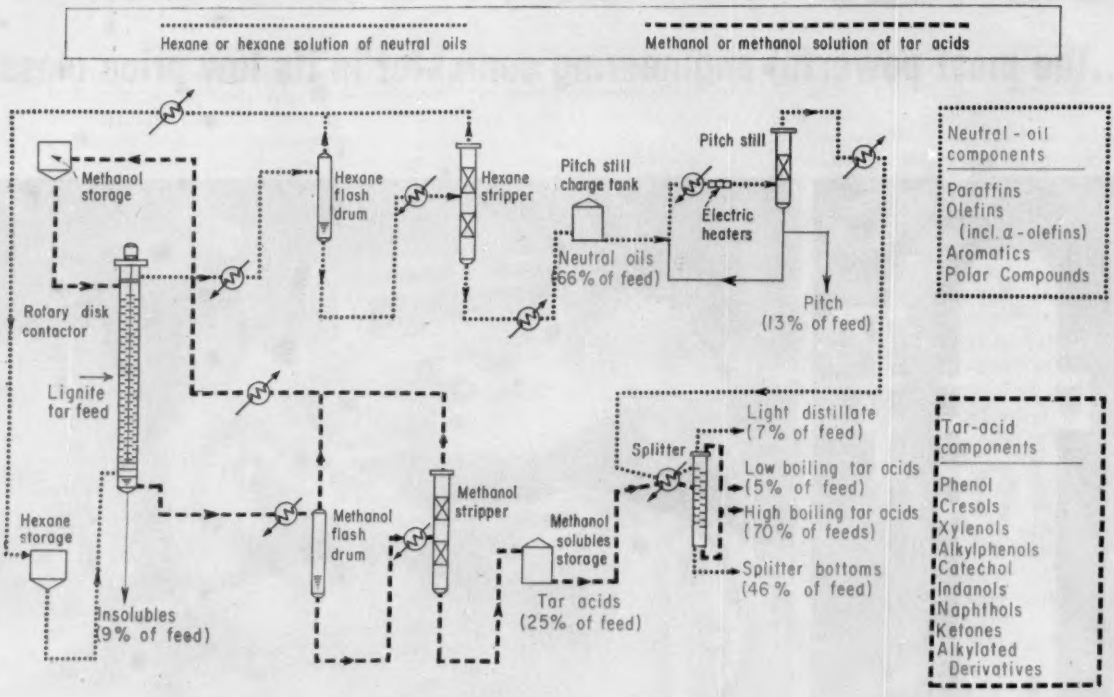
Transistorized throughout, the IBM 1620 has a 20,000-digit magnetic core memory with variable field length and immediate accessibility. Its input-output notation, on paper tape and console typewriter, is in convenient decimal arithmetic. It can perform more than 100,000 calculations a minute and is easily adapted to your engineering problems.

Easy to learn, easy to operate, easy to communicate with, the low-cost 1620 helps free your engineering talent for more creative work. And in keeping with our concept of Balanced Data Processing, the IBM 1620 is supported by extensive services. This includes a comprehensive library of mathematical routines and specific industry programs to permit you to put the 1620 to work without unnecessary delay.

Ask your IBM representative about the unique advantages of the IBM 1620. Like all IBM equipment, it may be purchased or leased.

IBM ® *balanced data processing*

Extraction, solvent recovery and fractionation produce tar products



Will Dual Extraction Set Tar's Future?

Striving to develop markets for new lignite tar, Texas producers try new dual-solvent extraction process to make tonnage fractions of tar for evaluation by users.

Utilization of lignite's chemical potential moves a step nearer realization as Texas Power & Light and Alcoa start producing lignite-tar fractions in a new pilot plant at Rockdale, Tex.

Using a dual-solvent extraction process developed by Battelle Memorial Institute, Rockdale converts 1,000 gal./day of crude tar from low-temperature carbonization of lignite into five neutral-oil and tar-acid fractions.

▶ **Caps Six Years** — With such quantities of tar fractions now available, TP&L and Alcoa are moving into active exploration and development of markets for the first time since Texas lignite won its job generating power for Alcoa's aluminum smelter in 1954. If successful, they will swing into full-time low-temperature carbonization of lignite, using the char, instead of lignite, for boiler fuel and processing the tar for chemical use.

Under rapid, low-temperature carbonization, lignite gives off a relatively uncracked tar which is a complex mixture of hydrocarbons and their nitrogen, oxygen and sulfur derivatives.

To convert this mixture into usable and marketable fractions, TP&L and Alcoa are relying on the new dual-solvent system. In the months ahead, market reaction will tell how well this system meets the need.

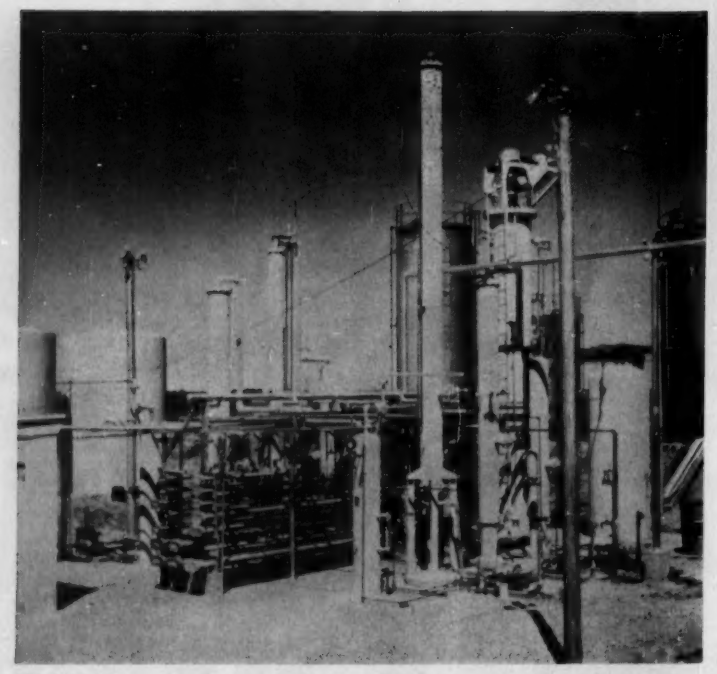
▶ **Who Will Use**—Potential applications of the tar fractions have not been publicized to any great extent. However, 11 companies have become participants

UNRULY UREA TOES THE LINE FOR 6 SOLID YEARS

Another demonstration of how well Aloyco Valves withstand the worst kind of corrosive conditions... many more years of service are expected. That's why engineers at Deere & Company's giant $20 million Oklahoma plant (went on stream in 1954) put many more Aloyco Valves to work. They buy performance. You'll find Aloyco Stainless Steel Valves in scores of processing plants, wherever severe conditions present difficult valve problems. Want to know more? Write: Alloy Steel Products Co., Inc., 1301 West Elizabeth Ave., Linden, New Jersey. o.2

ALLOY STEEL PRODUCTS COMPANY

Boston • New York • Wilmington • Atlanta • Birmingham • Baton Rouge • Buffalo • Pittsburgh • Chicago • St. Louis • San Francisco • Los Angeles • Seattle



TONNAGE tar fractions are flowing from pilot plant at Rockdale, Tex

in the development program. And the wood preserving and rubber industries are said to be particularly interested.

An all-important economic facet still is obscure, apparently. Nothing has been said regarding the breakeven point required for profitable operation, or about any other factors that would govern the return to be realized from commercial-scale production.

But one thing is certain; there's plenty of potential tar available. If sufficient lignite were carbonized to completely satisfy needs for power-plant fuel, 50 million gal./yr. of by-product tar would be produced. And if the economics of the venture prove favorable, this production rate can be reached in steps of 8 to 16 million gal./yr. as the market develops.

▶**Three-Step Process**—As designed by Pace Co., Houston, the Rockdale pilot plant includes extraction, solvent recovery and processing areas.

The extraction takes place in a rotating-disk contactor column using hexane and 75% methanol solution as solvents. Tar acids are extracted by the methanol, neutral acids leave with the hexane.

Solvent is recovered in flash drums and stripping towers. Products processing involves use of a pitch still on the hexane solubles and a splitter tower alternately for both the hexane solubles and the methanol solubles.

The lignite treating unit, which furnishes the tar feed, uses the Parry process. It can produce either dried or carbonized lignite, and tar is formed when the carbonizing alternate is employed.

▶**How Solvents Work**—Tar and the two solvents are preheated to 120 F. and fed to the contactor, a column 3 ft. in diameter and 16 ft. high, having 24 contacting stages. Tar enters around the midpoint, methanol solution at the top and hexane at the bottom.

Solvents pass countercurrently through the tower while acting on the tar. Material insoluble in either solvent collects as a semi-solid in the bottom and is drawn off periodically.

Important factors in successful extraction include temperature, solvent ratio and rotor speed in the contactor, as well as the concentration of methanol in the methanol-water solution. Solvent ratio used at Rockdale is 4:4:1, methanol solution to hexane to tar, and rotor speed is 40 rpm.

▶**Closed Solvent Cycle**—Solvent recovery procedure is the same for both the hexane and methanol streams. After leaving the contactor the streams are preheated and fed to flash drums, where about 70% of the hexane and 80% of the methanol solution are flashed off.

Reheating and passage through stripping towers completes the solvent removal. Solvent vapors are collected, condensed and returned to the contactor feed drums, with make-up water being added to the methanol solution as required.

▶**Split Out Products**—The solvent-free stream from the hexane stripper is lead to a charge tank, and, from the tank, through steam and electric heaters to a vacuum pitch still.

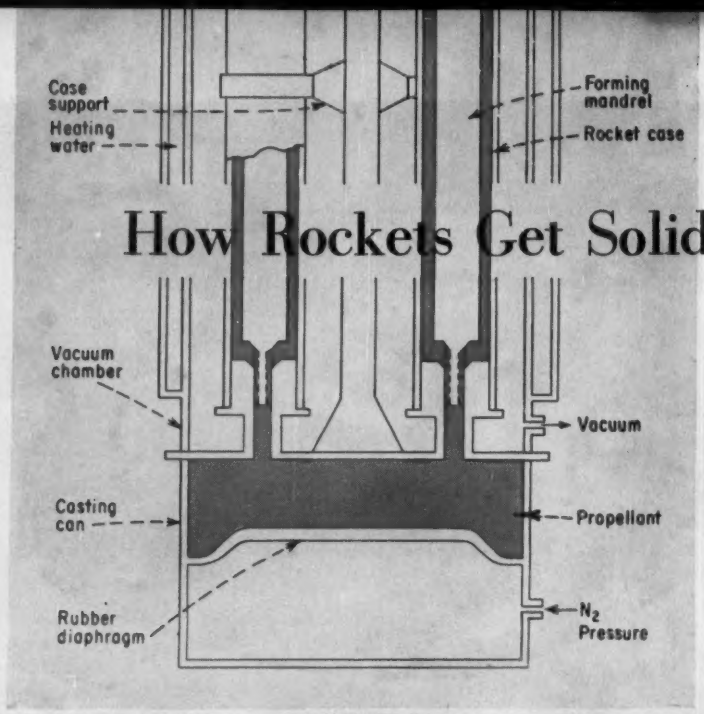
Enough distillate is taken overhead to leave a pitch bottoms of the desired softening point. This distillate is then separated in the splitter to produce light distillate and bottoms of the desired flash point and boiling range.

After methanol removal the methanol-soluble material is led to a storage tank. Water which did not pass overhead during solvent recovery is decanted at this stage. The material is fed to the splitter mentioned above, where fractions boiling above and below 250 C. are taken.

In practice the low boiling methanol-soluble materials and the pitch from the hexane-soluble stream are drummed directly. The other methanol-soluble fraction and the two hexane-soluble splitter products are pumped to storage.

Approximate yields and components of the five product streams are shown on the flow sheet. No information has been released on efforts to separate the component chemicals in them. Such separation likely would be difficult, and market development is apparently being aimed at finding uses for the mixtures as such.

Processes & Technology continues on page 74.



How Rockets Get Solid-Fuel Load

There's more to rocket fueling than frost-covered lines under a Florida sun. To fuel-up with solid propellant, maker casts through bottom.

Here is one way that Rocketdyne builds rocket motors—uniting solid propellant and rocket case into one high-powered package of space-oriented energy.

To line the rocket case with a relatively thin layer of propellant, Rocketdyne employs a bottom-casting technique at its McGregor, Tex., facility.

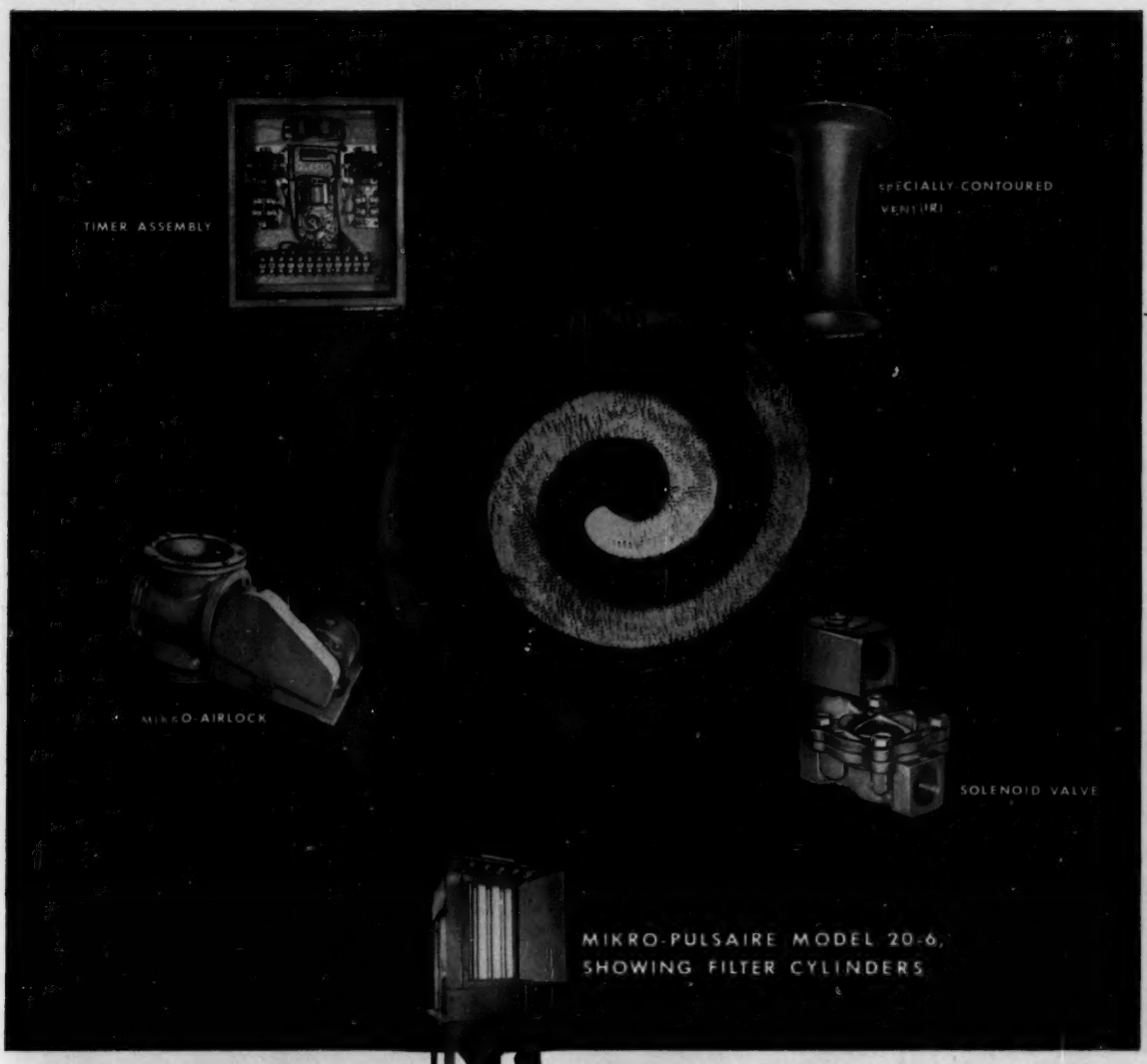
▶**Set Cases in Jig** — Empty rocket cases are placed in a special holding jig, as shown on left. Into each case goes mandrel to form annular space which will hold propellant. Finned extension on lower end of mandrel centers mandrel within case by fitting into propellant inlet tube.

Before inserting mandrel, workman sprays silicone over the Teflon-coated aluminum surface so that he can withdraw mandrel after propellant cures.

▶**Bottom Entry** — Propellant paste feeds into rocket cases through bottom inlets. To bring this about, the rocket case-mandrel assembly is enclosed within jacketed, evacuated chamber. This entire combination then fits onto a casting can holding the propellant paste.

Nitrogen pressure applied under diaphragm of casting can forces propellant into evacuated annular space inside rocket cases. By maintaining jacket water at 160 F., propellant fluidity is assured.

After casting, mandrels are dropped onto inlet seats to seal propellant into tube so that it can be compacted by vibration without leaking out through inlet. Then, rocket cases are re-



APPLYING TECHNOLOGY TO DUST RECOVERY...

Open the housing of the MIKRO-PULSAIRE Collector and you've discovered the secret of finer filtering efficiency and more economical dust recovery. You'll note there are no cams, gears, chains or other high replacement-cost components—no mechanical moving parts whatever! Product of Mikro research and development, the MIKRO-PULSAIRE is a simplified unit that provides full-time automatic cleaning with constant low-differential pressure . . . and a filtering efficiency of 99.9% plus. Maintenance, of course, is virtually eliminated, and bag life increased many times over, especially where abrasive or corrosive materials are concerned. There's a MIKRO-PULSAIRE for every industrial product recovery job, in single or modular units with capacities from 20 cfm to any known requirement . . . and the Mikro Laboratories are at your service to help you select the unit for your particular operation. For the complete story on sizes and capacities write for Bulletin 52A. It's yours without obligation.

MIKRO-Products
PULVERIZING MACHINERY
55 Chatham Rd., Summit, N. J.
A Division of Metals Disintegrating Company
Division of American-Marietta Company

SPAN THE GLOBE

PROCESSING SYSTEMS
GRINDING CONVEYING COLLECTING

REPRESENTATIVES throughout the United States, Continental Europe, British Isles, Canada, Mexico, Central and South America, West Indies, South Africa, India, Japan, Philippines, Australia and New Zealand.
MANUFACTURING FACILITIES: United States, Canada, Continental Europe, British Isles.

moved from casting jig and cured in oven at 170 F. for approximately 48 hr. Following cure, mandrels are withdrawn and propellant is trimmed and machined to ready it for firing.

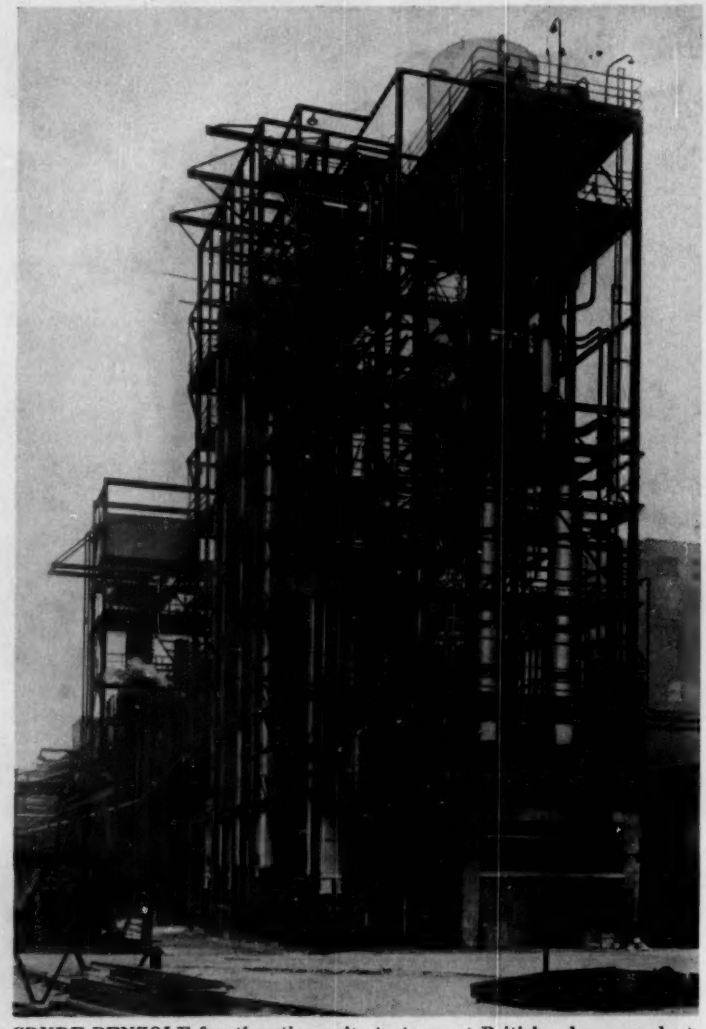
Chemicals Capital Bill: $1.66 Billion in '60-'61

Capital spending in the U. S. for new chemical-production and research facilities during this year and next will total $1.66 billion, predicts the Manufacturing Chemists' Assn. in its just-completed annual construction survey. Of this, some $1.2 billion represent outlays for new installations already under construction; the remainder for projects slated for early groundbreaking and completion before 1962. Survey covers firms not only in the chemical industry itself but also firms primarily identified with other industries such as petroleum, rubber and paper which are building chemical-producing plants.

Chemical category pacing the building activity in the MCA survey is general inorganics with an expected capital bill for 1960 and 1961 of some $686 million. This category placed second in last year's study. General organics, last year's leader, is in the second slot this year with a total '60-'61 spending of about $675 million. Petrochemicals are in third place, up from last year's fifth, with $455 million; plastics and resins are fourth, down from third, with $450 million; lab construction is fifth, up from ninth, with about $221 million; fertilizer chemicals sixth, up from seventh, with $116 million; synthetic fibers seventh, down from fourth, with $101 million; chemical metals eighth, down from sixth, with $86 million; synthetic rubber ninth, down from eighth, with $45 million. A miscellaneous category makes up the remaining $167 million.

Total construction projects for each category: Organics, 202; inorganics, 179; plastics and resins, 128; labs, 108; petrochemicals, 35; fertilizers, 29; metals, 19; synthetic fibers, 9; synthetic rubber, 8; miscellaneous, 102.

INDUSTRY NEWS

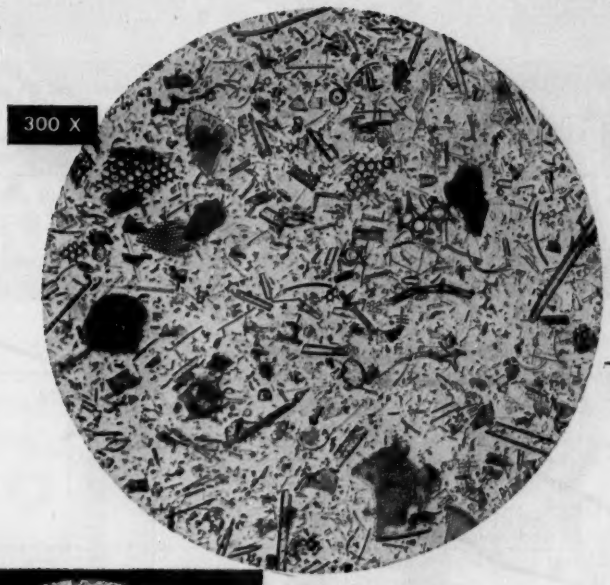


CRUDE BENZOLE fractionation unit starts up at British coke oven plant.

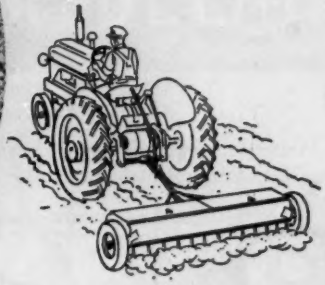
Appleby-Frodingham Steel Co., a branch of United Steel Co., Ltd., has placed on stream Britain's first fractionation unit to produce nitration-grade benzene, toluene, xylene and naphtha from coke oven gas. New unit at Appleby's Scunthorpe Coke Oven & Chemical Plant produces 5.5-million gal./yr. of aromatic product. APV Co., Ltd. designed and constructed the five-column unit, that includes an APV Continuous Defronting Unit for carbon disulfide removal.

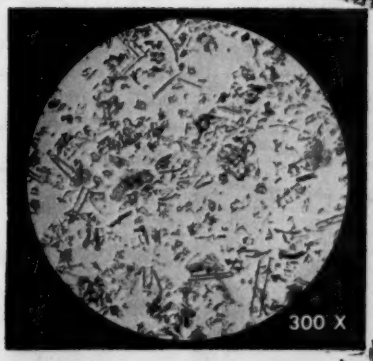
Dow Chemical Co. discloses plans for a $30-million expansion of its Plaquemine, La., heavy chemicals facility. Construction, already under way, includes anhydrous and aque-

Industry News continues on page 176.

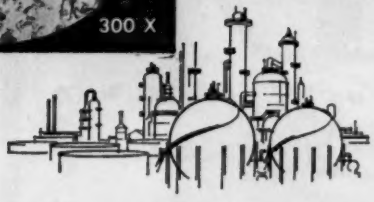


For fertilizer caking—Celite 379, a natural milled diatomite, provides the uniform conditioning needed to prevent caking of granular, mixed or prilled fertilizers—maintains good free-flow characteristics even after prolonged storage.

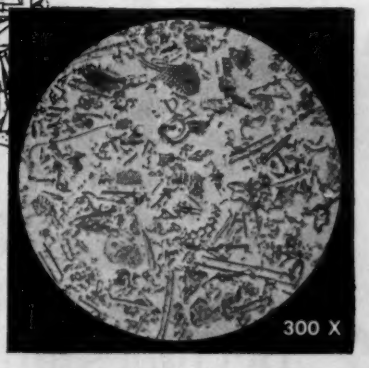




For catalyst carriers—Super Floss, finest particle size flux-calcined Celite grade, is used where a non-reactive porous silica support is needed. (Also available: special Celite supports in many preformed shapes for strength, high temperature stability, resistance to abrasion and attrition.)



As a paint-flatting agent—Celite 281, air-floated fines of flux-calcined diatomite, provides uniform and efficient flatting at low cost. Contributes to control of low angular sheen, durability, and faster drying.



In diatomites, Johns-Manville precision processing works for you

Celite diatomite absorbs its own weight of liquid . . . yet stays 'dry'

No matter which of the many available grades you choose, you can depend on a given volume of inert Celite* to retain its typical dry-powder characteristics even after absorbing its own weight of liquid.

Actually, Celite can absorb a total of more than twice its own weight. That's because a mass of the fine skeletal particles is approximately 93% air space or voids. Yet, in spite of this very high porosity, Celite is essentially non-hygroscopic.

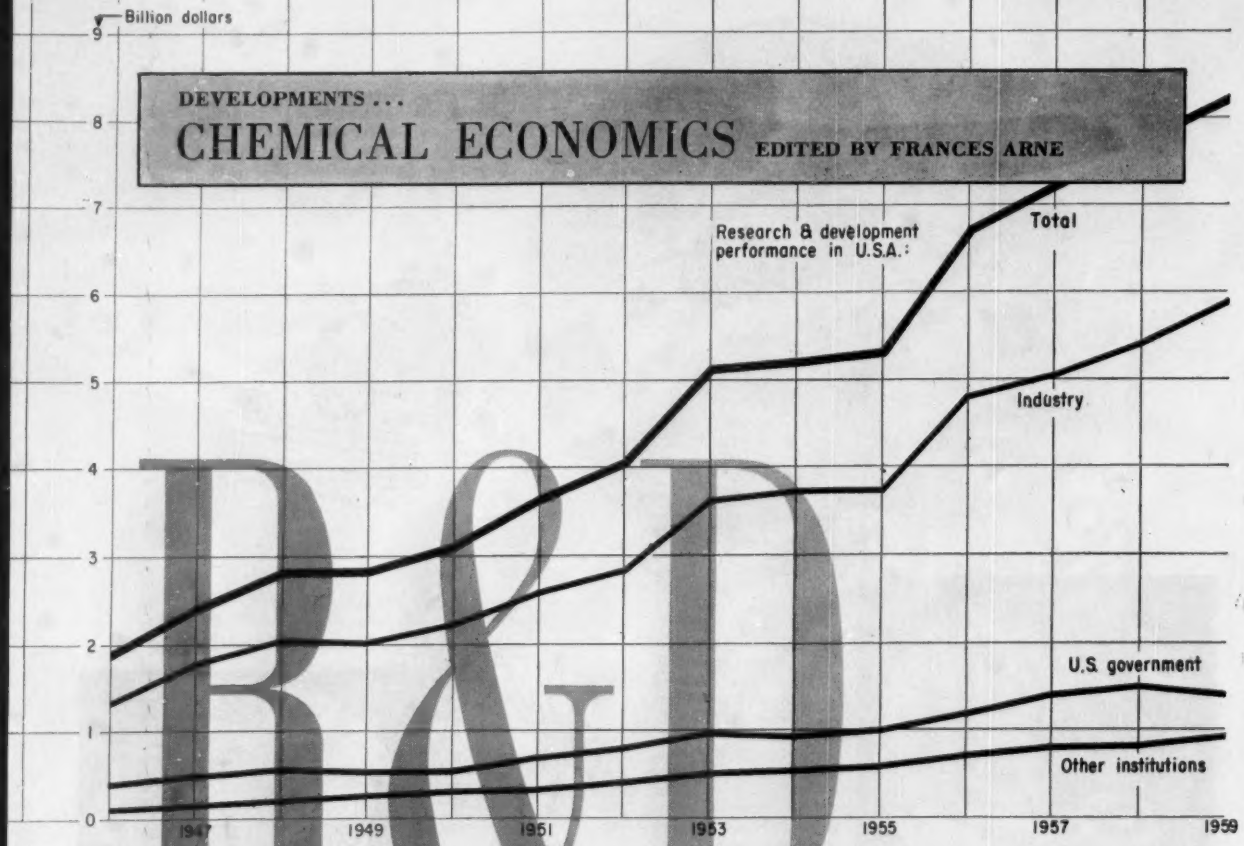
Other unique properties—extremely high bulk, irregular particle shape and large available surface area—ideally suit Celite to hundreds of mineral filler applications. It is produced with precision from the world's purest commercially available diatomite deposit. It offers a wide choice of grades, each carefully controlled for complete uniformity.

For technical data on specific mineral filler or filtration problems, talk to your nearby Celite engineer. Or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

*Celite is Johns-Manville's registered trademark for its diatomaceous silica products

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS



R&D Becomes an Industry Necessity

Industry now acknowledges the relationship by performing $6 billion worth, or 71%, of the nation's research and development. In return, new products will count for 13% of this year's sales.

Industry's image of research and development is looking more and more at home in the kitchen. Prior to World War II, it bore a closer resemblence to some remote diety—worthy of remote approval for the public record, but hardly the sort of thing to embrace and support at home.

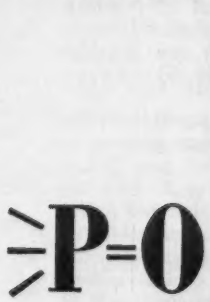
Confirmation of the transformation emerges, unforced but forcefully, from a new and unusually comprehensive compilation of R&D data from all major sources. A PhD dissertation by G. P. Giusti for the University of Pittsburgh, it aims at evolving a systematic history of expenditures for research and development in the United States since World War II.

Rare conjunction of all data compels recognition of R&D's move—in a new role of essential contributor to profits—from the periphery in towards the core of industry operations.

▶ **Growth Accelerates** — Less than 2% of gross national prod-

G. P. GIUSTI, from whose dissertation this article was abstracted, works for Texas Gulf Sulphur Co. in a capacity he describes as a mixture of engineering, statistics and economics. He received BS and MS degrees in chemical engineering and a PhD in economics from the University of Pittsburgh. While at school, he did chemical engineering research part time at Mellon Institute under a TGS-sponsored fellowship.

PLASTICIZERS FROM CELANESE



LINDOL: *Tricresyl phosphate, low color.* Low volatility, good resistance to extraction by oils, superior color. Standard for vinyls and cellulosics.

CELLUFLEX 179A: *Tricresyl phosphate, low specific gravity.* Lowest ortho content commercially available.

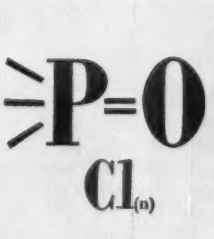
CELLUFLEX 179C: *Tricresyl phosphate, general purpose grade.* Excellent solvent power and flame retardance. Low volatility. For coatings and films demanding toughness and flame resistance.

CELLUFLEX 179EG: *Tricresyl phosphate, electrical grade.* To make plastic insulations. Offers flame resistance, outstanding electrical properties, low weight per unit volume.

CELLUPHOS 4: *Tributyl phosphate.* Plasticizer for resins and rubbers. Foam depressant. Selective solvent.

CELLUFLEX TPP: *Triphenyl phosphate.* Excellent fire resistance, good flexibility. Produces clear, tough compositions. Widely used for cellulose acetate.

CELLUFLEX 112: *Cresyl diphenyl phosphate.* High degree of flame resistance in vinyl formulations. Improved low temperature and light exposure properties.



CELLUFLEX CEF: *Tris beta-chloroethyl phosphate.* Exceptional flame retardance.

CELLUFLEX FR-2: *Tris dichloropropyl phosphate.* Exceptional flame retardance. Effective with wide variety of resins, both thermoplastic and thermosetting.

CELLUFLEX 23: *Alkyl epoxystearate.* Economical low-temperature plasticizer and stabilizer for polyvinyl chloride and other polymers. Very low volatility.

A thought to keep in mind—Celanese' shipment policies permit quick action to meet tight schedules. We ship from convenient points throughout the United States. We'll be glad to provide you with specifications on any of these plasticizers. For more information, write to: Celanese Chemical Company, a Division of Celanese Corporation of America, Dept. 553-D 180 Madison Avenue, New York 16, N. Y.

Celanese® Lindol® Celluflex® Celluphos®

Canadian Affiliate: Canadian Chemical Company, Limited, Montreal, Toronto, Vancouver
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N. Y.

Celanese CHEMICALS

Between 1947 & 1958
R & D Outlay Grew 160%

	Industry Expenditures		Percent Change	
	New Plant & Equipment	Research & Development	New Plant & Equipment	Research & Development
	(Millions of Dollars)		(Percent)	
1947	20,612	1,315	39	47
1948	22,059	1,475	7	11
1949	19,285	1,370	−13	−7
1950	20,605	1,615	2	18
1951	25,644	1,900	24	18
1952	26,493	2,035	3	7
1953	28,322	2,406	7	18
1954	26,827	2,400	−5	0
1955	28,701	2,400	7	0
1956	35,081	3,430	22	43
1957	36,962	3,500	5	2
1958	32,074	3,600	−13	3
				160%

uct is devoted to the conduct of research and development in the United States. Quantitatively, therefore, this cannot be considered a large industry. In fact, covering the entire history of the nation until 1946 only an estimated $4½ billion was spent on research and development. However, during the next 13 years—1946 through 1958—research expenditures were about $60 billion.

It is expected that the nation's total research bill for 1959 will be over $8 billion, growing from about $2 billion in 1946.

These figures exclude testing and evaluation expenditures, which—in recent years—many have been including as research and development. Currently the government supplies funds to support 51% of the United States' total research and development with industry supplying 46%. Colleges, universities and other institutions supply funds for the remaining 3%.

▶ **Support Shifts** — Prior to World War II private industry was the main sponsor and performer of research. However, since 1940 the federal government has become a major contributor while industry remains high for performance. Federal expenditures for research and development rose from less than $400 million in 1941 to an estimated $4.3 billion for 1959. Expenditures by private industry increased from $500 million in 1941 to an estimated $3.7 billion in 1959.

▶ **Industry Heads Performers**—Not only is industry a major supporter of research and development, it also is a major performer, conducting 71% of the U. S. total. While colleges, universities and other institutions contributed only a little over $200 million for the conduct of research and development, they perform over $900 million. Their performance equals 11% of the nation's total and approaches the 18% performed by the federal government.

Major reason for governmental increases has clearly been national security. Industry's motivation is more diffused.

▶ **Image Changes** — Research has lately been described as our most productive industry. A fairly recent study predicted that new products will account for 13% of all manufacturers' sales by 1960, compared with roughly 8% in 1956. A 1953 study found that, roughly, the rate of return by industry descends with the rate at which expenditure on research descends.

Today, 50% of the nation's workers are employed in industries that did not exist in 1880. New major industrial developments in the last ten or fifteen years alone include: Television, wonder drugs and vitamins, frozen foods, air conditioners, man-made fibers, plastics, jet aircraft and atomic energy usage.

According to one estimate, research and development conducted during the preceding 25-yr. period contributed $40 to $80 billion to the gross national product in 1954. These figures indicate the portion of GNP which would not have resulted if there were no research and development activities beyond the year, 1928.

Research is responsible for increases in capital expenditures in that it has created new industries and therefore created demands for new plants and equipment. It also is responsible for decreases in that research should permit a lower capital investment per unit of production than no research at all for the same process.

▶ **Barometers Outstripped**—The fact that industry has been considering research fairly important can be documented by its growth in relation to other business items. From an index of 100 in 1947-1949, industry's research and development expenditures increased to 260 in 1958. On the same basis the 1958 values of other items were: GNP, 175; manufacturing sales, 158; Federal Reserve Board index of industrial production, 134.

Since 1947-1949 to 1958 industry's research and development expenditures grew by 160%. This period saw increases of 108% in advertising expenditures and 55% in plant and equipment outlays.

▶ **Competitive Research**—More and more today it is being recognized that one of a company's more competitive expenditures is for research and development. A certain minimum amount is basically necessary to hold one's position or to keep even with competitors. These minimum expenditures have been termed defensive expenditures. Money spent above this minimum may be looked upon as offensive research. Essentially, this is the research that is responsible for new products and processes and major industrial and scientific advances; the former is geared

Rise in R & D Spending Paces Chemical Sales' Rise

	Expense Rise 1950–1956	Sales Rise 1947–1957
	(Percent)	
Allied Chemical	75	83
American Cyanamid	82	133
Atlas Powder	50	77
Dow Chemical	212	276
Du Pont	103	114
Hercules Powder	128	93
Monsanto	292	158
Union Carbide	244	141

more for preserving present product lines.

▶**Government Accents Defense**—All national security research and development expenditures by the federal government account for about 90% of the present day federal expenditures for research and development. Expenditures by the Department of Defense mounted from $25 million in 1940 to over $2 billion in 1959—excluding pay and allowances for military personnel and further developmental procurement funds.

This is a definite change from the pre-World War II era when a major portion of federal research and development expenditures was in such areas as agriculture, education, welfare and health. In 1954, defense research accounted for about 86¢ out of every federal research dollar, compared with about 20¢ in 1938.

Such large increases in federal research and development expenditures also caused another change to take place. Prior to World War II much of the work was done in the government's own laboratories; now about half is farmed out to private organizations.

From 1946 to 1959 industry research and development expenditures increased by a factor of 4.2 while performance increased 4.4 times. Increased sponsorship by the government has been responsible for the faster rise of industry's performance over its expenditures. In fact, about 40% of all the research and development performed by industry is under the auspices of the federal government.

▶**Research Channels**—Of the total government expenditures, 10% was for basic research, 25% for applied research and 65% for development. Also, 60% of these total expenditures were extramural; 70% of the federal outside expenditures went to profit organizations, 25% to educational institutions and the remaining 5% to other institutions.

Of the total industry research and development expenditures only about 4% was spent outside of the spending company. About 7% of industry expenditures and only 4% of their research performance was for basic research; however, these represent 41% and 36%, respectively, of the total U. S. basic research.

Of the total basic research expenditures some 36% came from the federal government; colleges, universities and other institutions supported the remaining 23%. On the score of performance, the federal government was responsible for 14%. While colleges and universities performed less than 10% of all natural sciences research and development in the nation, they performed almost half of the nation's basic research.

▶**Basic Research**—As late as 1947 it was estimated that industry's contribution to basic research was only about $10 million. Its present figure is estimated at about $250 million. At the close of World War II, total expenditures for basic research were about $100 million annually. Current figure would probably be close to $600 million.

There is reason to believe that the United States supports more basic research than any other single country. Yet the potential of its scientists exceeds the support available by a considerable amount, and only about ⅛ of 1% of GNP is devoted to basic research.

▶**Traces of Goddess**—Many companies are aware of the importance of basic research but it is still very difficult to raise industrial money for it. While most firms agree that it is worthwhile, they find it difficult to appreciate where it contributes to near term profits for their individual companies.

A few surveys were conducted to determine when industry expected to reap the benefits of research and development expenditures. These surveys indicated that most companies expected returns in three to five years and many even less. This clearly indicates that most of the research and development work was nearer the development side.

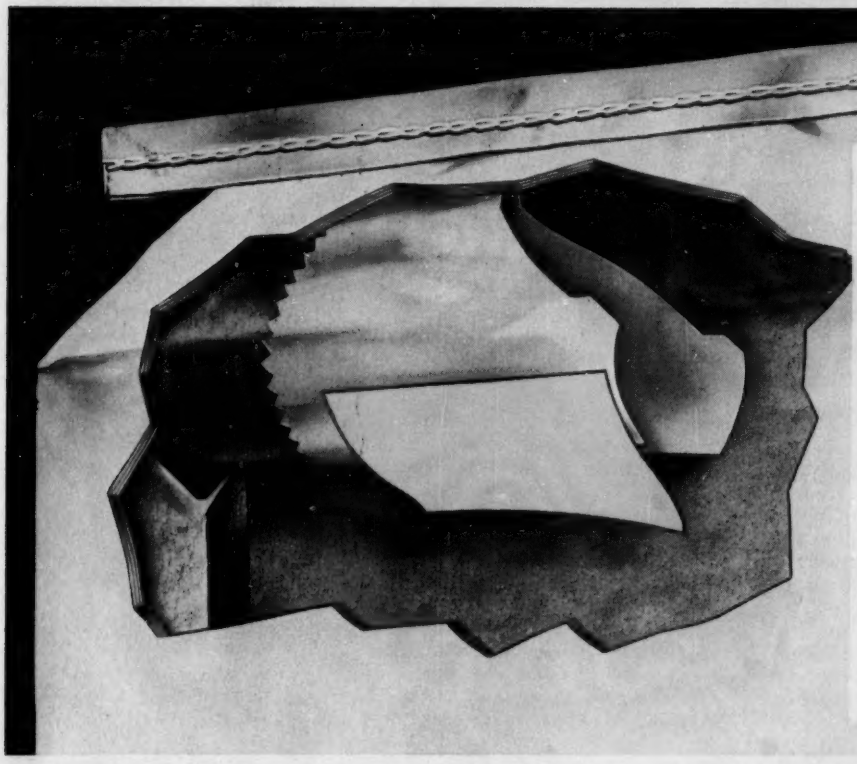
▶**CPI Leaders**—In looking at the industry breakdown for the performance of basic research it is observed that chemicals and allied products conduct about 25% of the basic research in industry followed by electrical equipment—13% and aircraft and parts—12%. Also, a large portion—11%—of the chemical industry's total research and development performance is devoted to basic research.

When the federal government's support of industry's research is included, aircraft and parts—at about $2 billion—far surpass other industries in the performance, dollar-wise, of all research and development. Next in line of performance is the electrical equipment industry at $1 billion, followed by the chemicals and allied products industry at about $0.5 billion.

Another picture is obtained when government funds are excluded. Statistics on industry's intramural expenditures by industry classification for the performance of research and development show the chemicals and allied products industry in the forefront for performance based on industry expenditures.

▶**CPI Harvest**—To pursue research and development expenditures by the chemical industry further: In general, the companies that have made greatest

Bemis *Duette*® Sewn Multiwall Sleeve Valves Have Been Experience-Proved

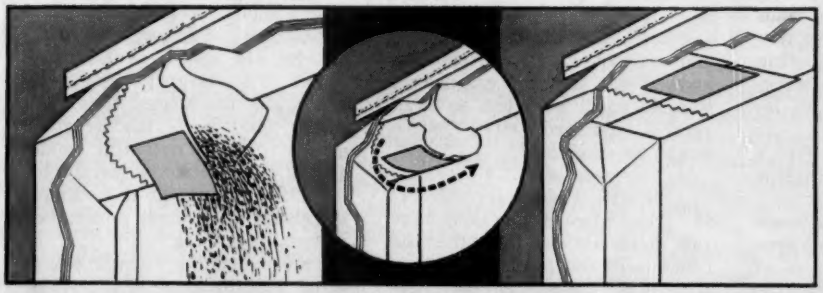


A Few of the Prominent Bemis DUETTE Valve Multiwall Users

- Alliance Fertilizer
- American Cyanamid Company
- Aroostook Hi Test
- Best Fertilizers Co.
- Central Chemical
- Hubbard Hall
- Lincoln Service & Supply
- Miller Chemical & Fertilizer Corp.
- N. S. Koos & Son Co.
- Shur Gain
- Texas Mining & Smelting

It's been more than three years since Bemis perfected the DUETTE, the multiwall bag valve-on-a-valve that gives double sift protection for granular, pelletized or pulverized products.

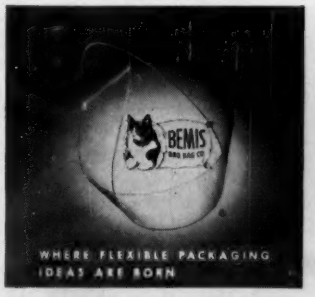
In that time, DUETTE Multiwalls have been used by many of the leading chemical and fertilizer manufacturers, with consistently gratifying results. The diagrammatic pictures show why . . .



WON'T CLOG . . . The Magic Yellow check flap falls freely aside from the valve slit. The sleeve won't choke or clog the packing spout.

POSITIVE CLOSING ACTION . . . This diagrammatic picture shows the action as the Magic Yellow flap starts to close over the valve slit.

CAN'T SIFT . . . When the bag is filled, the flap, acting as a check valve, completely overlaps and covers the valve slit, to stop sifting.



General Offices
408-R Pine Street
St. Louis 2
Sales Offices in Principal Cities

sales increases and have had high returns on net worth, also have increased their research budgets the most. Du Pont estimated that about 27% of its 1955 sales resulted from additions to product lines in the postwar period. Monsanto's 1953 annual report stated that during 1953, a large portion of its sales and approximately 40% of its profits came from products not manufactured ten years earlier. Also in 1953, Chas. Pfizer introduced 78 new or radically improved products. General Electric's 1957 annual report indicates that about 35% of its 1957 sales resulted from new products now produced prior to World War II.

Consultants Need Proper Priming

The better the focus of a client's questions, the better the buy he'll get from chemical consultants.

The industrial client-industrial consultant relationship is a two-way street and, to be worth anything, had better incorporate substantially more than fees in the client-to-consultant direction. To give significant answers, a consultant must know what the questions are.

Roger Williams of Roger Williams Technical & Economic Services recently drove home this point—and the surprising frequency with which it is overlooked—with a series of case histories presented before the Assn. of Consulting Chemists & Chemical Engineers:

One thing a client must know is what he wants to know. Oftentimes he will merely ask the vague question: What are the markets and economics of ethylene dibromide? The consultant could dig up information on cost of production and hence potential profit based on current sales prices. He could develop the economics of possible competing processes. He could do a workmanlike job and submit an invoice.

But suppose the client had a byproduct containing ethylene dibromide and could thus produce it inexpensively and hence undercut the entire market, even below the out-of-pocket cost of existing producers. If the consultant knows this, he is going to gear his whole market and economic study differently. There will be a limited raw material supply—since the ethylene dibromide raw material supply is geared to the markets for the other material. Too often this sort of information is not given the consultant before he starts. This means, first, that his proposal can be a poor one. He must guess what the client really wants. This may result in a poor proposal that the potential client will not accept—not necessarily because of any fault on the part of the consultant, simply because he was given too little information to go on.

Or if the client does decide to have the study carried out, the final result will be that the client decides it was of no value—or, worse, that it had a negative value.

On one occasion, Williams' firm did a general market study on a given petrochemical. After the first study, which was on all U. S. markets, they studied only a given area where this client had available raw materials. The answer was that the given area was no good, but that an area several hundred miles north might be excellent.

So they worked out a potential merger with a marketer. Everything looked good then except for raw materials and for a fact the consultants did not know at that time—that this company required a 100% vote of its Board of Directors on a project and that some of the Board members wanted to put the available money elsewhere. So the whole project was dropped.

The only trouble was that a number of other companies (one in particular) decided that making chemical X in that area or marketing it there would be a good idea. And as far as the U. S. as a whole was concerned, a number of companies just decided to go into the business. Result: lower prices, lower profit margins.

The client was still happy until a certain member of their Board came along with a question about five years later. He wanted to know why the consulting firm had recommended a product on which profit margins had dropped. The consultants checked and found that their previous market forcesasts had been "off" by less than 5%. They didn't and couldn't forecast the others that went into the business. Hence, the value of their work was a negative value to the client.

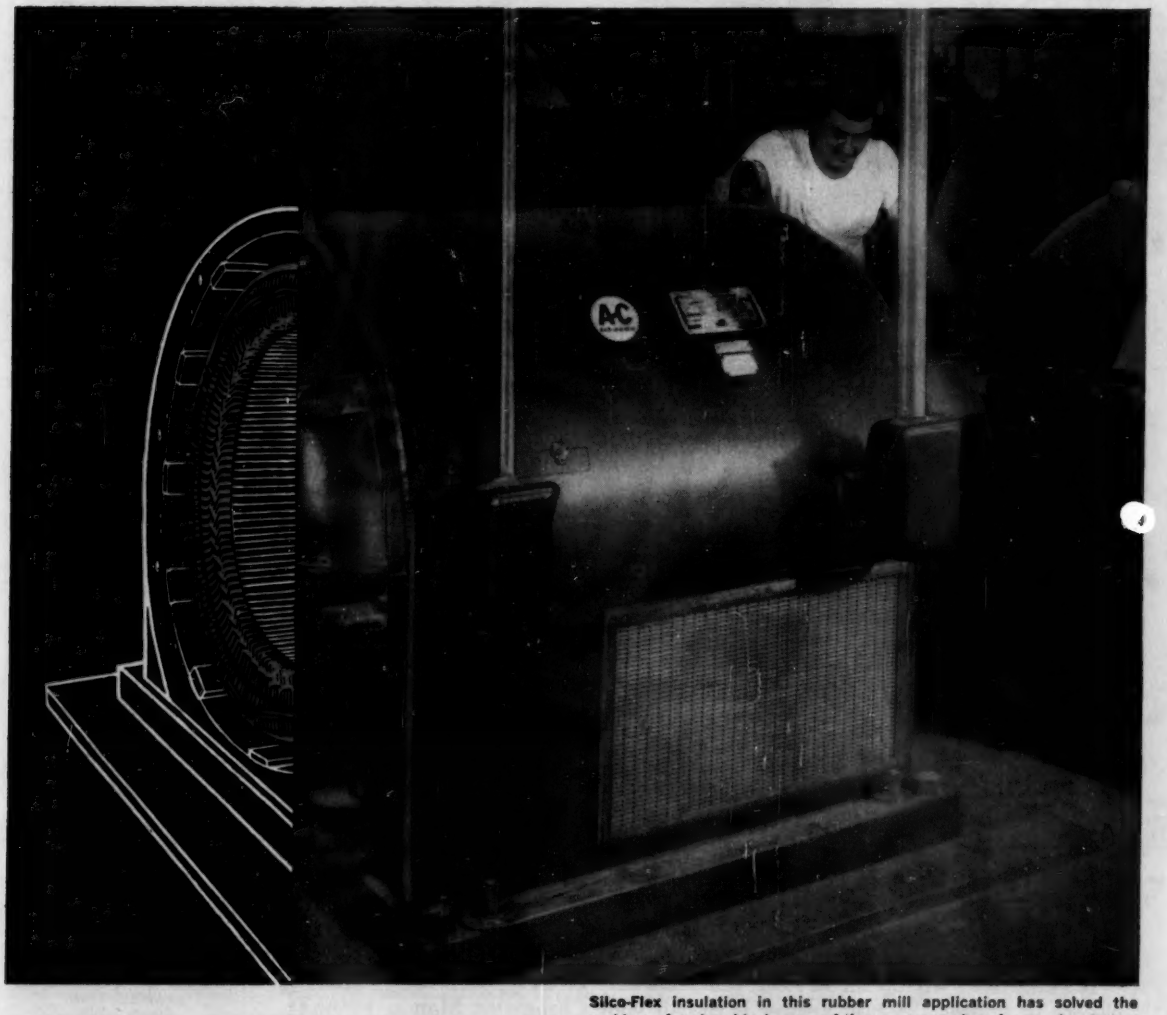
But if the client had gone ahead they might well have scared off some of these other people from entering production, profits might have held, this particular client might have been making more money—and the consultants would not have had one of their outside directors asking such questions.

One other story deals with the value a client can obtain from a consulting market and economic study. It involves a chemical called "A" this time. The client had the raw materials and it had a process; the market was growing and the client's own market research personnel had done a study; the future markets looked good.

Why were consultants called in to do a duplicate study? The consultant doesn't know to this day but he did discover one little thing. The largest then producer, also the largest then consumer, and with the greatest market growth potential, could double their capacity merely by installing a $10,000 still. Ergo, the client would have no market to speak of.

This ended the client's plans. What was the value of the study to the client? The vice president in charge of sales of that company told the consultant it saved them over 1,000 times the fee.

ALLIS-CHALMERS



Silco-Flex insulation in this rubber mill application has solved the problem of carbon black—one of the worst enemies of motor insulation.

Your major motor investments are protected by Allis-Chalmers

invisible standards of perfection

Allis-Chalmers motors prove the value of thinking beyond established design standards. This thinking, applied to research, development and manufacturing, has led to advanced design features which mean greater application versatility, exceptional reliability and extended motor life. These are invisible standards of perfection you get with Allis-Chalmers motors.

Silco-Flex insulation, for example, has completely changed the rules on open-motor application. It is impervious to moisture, oils, and most acids, alkalies and solvents. It is resistant to abrasion, and is capable of withstanding high temperatures. Its resilience provides durability to withstand shock and vibration.

Super-Seal motors, with *Silco-Flex* insulation, have proved themselves for more than five years under the most severe conditions in industry.

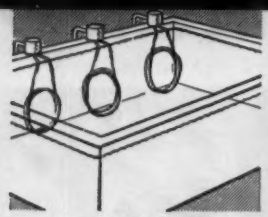
Advancements such as capsule bearings, split end housings, and *Integrated* field coils (for synchronous motors) add to the superior performance of *Super-Seal* motors.

They contribute to the invisible standards that protect your motor investments year after year — cut replacement costs — assure uninterrupted production.

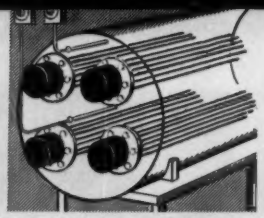
To learn more, call your nearby A-C representative, or write **Allis-Chalmers,** *Power Equipment Division, Milwaukee 1, Wisconsin.* A-1290

Super-Seal and Silco-Flex are Allis-Chalmers trademarks.

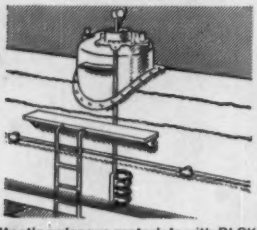
Call your CHROMALOX Man for heating answers



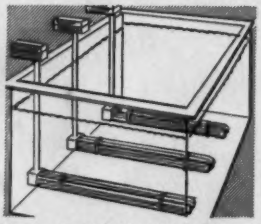
For plating applications, Chromalox CT Immersion Heaters are sheathed in lead, copper, stainless steel.



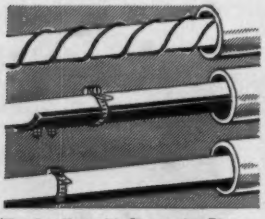
Water heating with TM flange-type Immersion Heaters mounted at one end of a tank.



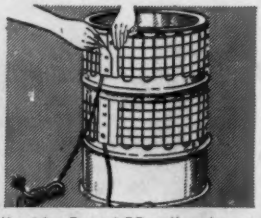
Heating viscous materials with BLCK Immersion Heaters before pumping from a railroad tank car.



Heating liquid held at constant level. TL Heaters generate heat parallel to the tank bottom.



Pipe heating with Chromalox Thermwire (300°F), Strip Heater (750°F) and Tubular Heater (1100°F).



Heat for 5- and 55-gallon drums. Just snap on and plug in. Protective coating resists abrasion, chemicals.

LIQUIDS? Only CHROMALOX heats so many things . . . so many ways

There's one best way to do any job. And you get the best results only by using that one best method.

Regardless of what your heating problems may be . . . your best chance of finding the best answer is to call your Chromalox Man.

- He represents more than 15,000 different types, sizes and ratings of electric heaters and heating elements . . . the world's largest line.
- He orders from the world's largest stock.
- And he is a *heating expert* . . . he understands your problem and can help you find the answer.

No matter what your heating problem is . . . solids, liquids or gases . . . call your Chromalox Man for the efficient, *electrical* answer. (*His phone number is listed at the right.*) Or, check the boxes below, write your name, title, and address at the bottom of this page and mail the coupon to us. Edwin L. Wiegand Company, 7500 Thomas Boulevard, Pittsburgh 8, Pa.

- ☐ Send me Catalog 60 (General Industrial heating applications).
- ☐ Send me specific information on the heating problems I have outlined on the sheet attached.
- ☐ Have a Chromalox Representative contact me.
- ☐ Do not have a Chromalox Representative contact me.

91948

Sales-Engineering Representatives

ALBANY, N.Y. Hobart 3-0626
ATLANTA, GA. Trinity 5-7244
BALA-CYNWYD, PA. Mohawk 4-6113 Greenwood 3-4477
BALTIMORE, MD. Hopkins 7-3280
BLOOMFIELD, N.J. Edison 8-6900 New York: Worth 4-2990
BOSTON, MASS. Liberty 2-1941
BUFFALO, N.Y. Summer 4000
CHARLOTTE, N.C. Edison 4-4244 Franklin 5-1044
CHICAGO, ILL. Harrison 7-5464
CINCINNATI, OHIO Trinity 1-0605
CLEARWATER, FLA. Phone 3-7706
CLEVELAND, OHIO Prospect 1-7112
COLUMBUS, OHIO Amherst 7-8260
DALLAS, TEX. Riverside 8-9004
DAVENPORT, IOWA Phone: 6-5233
DENVER, COLO. Glendale 5-3651 Genesee 3-0821
DES MOINES, IOWA Cherry 3-1203
DETROIT, MICH. University 3-9100
HOUSTON, TEX. Capitol 5-0356
INDIANAPOLIS, IND. Melrose 5-5313
KANSAS CITY, MO. Victor 2-3306
LOS ANGELES, CAL. Richmond 7-5191
MIDDLETOWN, CONN. Diamond 6-9606
MILWAUKEE, WIS. Broadway 1-3021
MINNEAPOLIS, MINN. Federal 6-6631
NASHVILLE, TENN. Cypress 2-7016
NEW YORK CITY, N.Y. (See Bloomfield, N.J.)
OMAHA, NEB. Atlantic 7600
PHILADELPHIA, PA. (See Bala-Cynwyd, Pa.)
PITTSBURGH, PA. Emerson 1-2900
PORTLAND, ORE. Capitol 3-4197
RICHMOND, VA. Atlantic 8-8758
ROCHESTER, N.Y. Hamilton 6-2070
ST. LOUIS, MO. Chestnut 1-2433
SAN FRANCISCO, CALIF. Underhill 1-3527
SEATTLE, WASH. Main 4-7297
SYRACUSE, N.Y. Granite 4-3933
WICHITA, KAN. Amherst 2-5647

CHROMALOX *Electric Heat*
INDUSTRIAL · COMMERCIAL · RESIDENTIAL

CHEMICAL PRODUCTS EDITED BY FRANCES ARNE

Paving Materials Take On Color

Brilliant white curbing, being installed above, is one of several applications foreseen for colored paving materials. Techniques for compounding and applying such materials are now under development, with results appearing promising.

Color is introduced by using plastics, which can be pigmented any hue, as aggregate binder in a mixture applied as a surface layer about one inch thick. Plastics used have included polypropylene, polyethylene and polyisobutylene.

Possible applications in addition to curbing include airport runways, traffic lanes in cloverleaf and other highway interchanges, tennis courts, swimming pools, sidewalks and home driveways. Successful experiments have been conducted involving test road strips, curbs and an oil drum storage lot; also planned are full scale tests on public roads and airport areas.

Proper choice of plastic can lead to other advantages such as resistance to oil. Reported to be very hard and strong, the mixtures can be prepared and laid with standard equipment and methods.—Esso Research & Engineering Co., Linden, N. J. 88A

Polycarbonates

New polymer family finds use with photographic film.

The use of polycarbonate polyesters, a relatively new class of polymers, in a dimensionally stable film base has been announced. The polycarbonate-containing photographic support, named Plestar, is said to be far more stable than the conventional cellulose acetate or mixed cellulose ester films.

The new base is particularly inert to changes in humidity. Because of its higher softening point, it does not show the same degree of distortion at high temperatures as cellulose esters or polystyrene. Dimensional changes of sensitized films on Plestar base, over a wide range of temperatures and humidities, do not exceed 5 parts in 10,000.

The material is made by a solvent casting operation so as to maintain maximum optical clarity and surface smoothness. It is not biaxially oriented, thus avoiding latent stresses that cause distortion on aging and at elevated temperatures. Physical properties permit normal handling and cutting techniques.

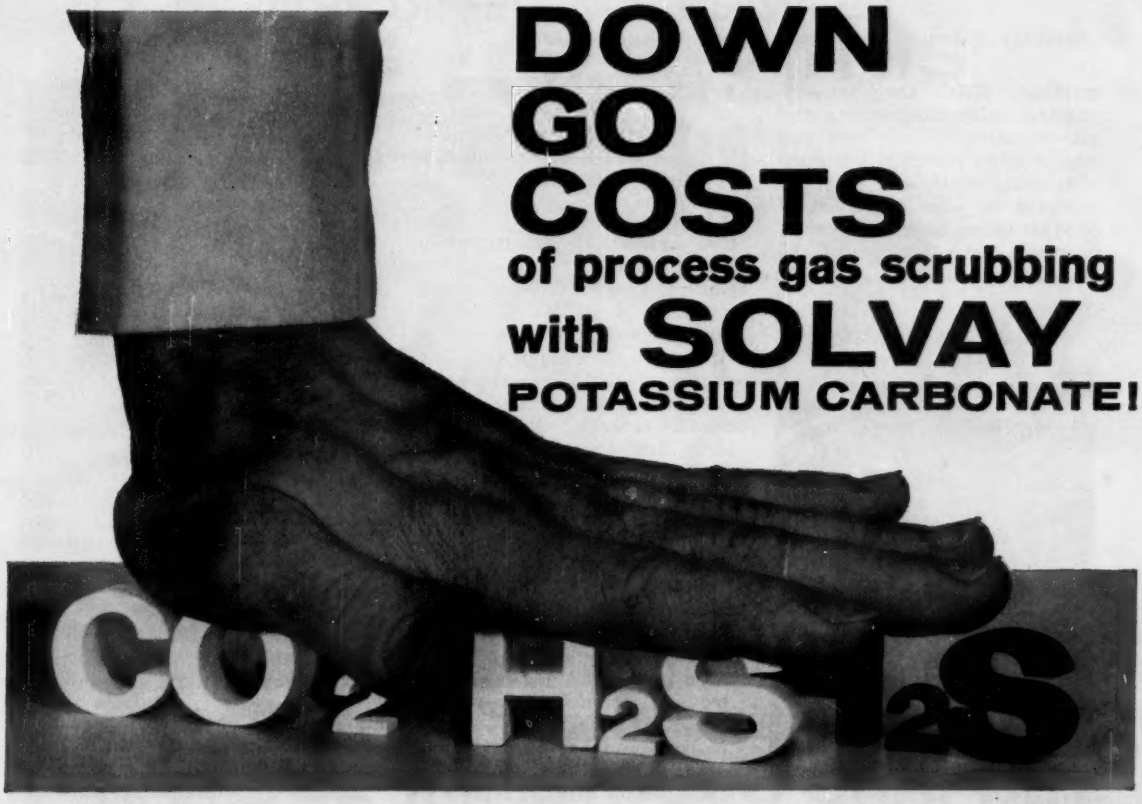
Becoming available during the first half of 1960, film using the new base will initially be used in connection with graphic arts and military products where dimensional stability is important. — Ansco Division, General Aniline & Film Corp., Binghamton, N. Y. 88B

Epoxies for Molding

New compounds suitable for high-speed production.

New epoxy compounds having soft-flow molding characteristics have been announced as a significant development for rapid, mass production of computer and missile components. Applications already current range from molding of miniature electronic parts smaller than a paper clip to the manufacture of giant transformers.

Known as EMC, the compounds are said to incorporate a good balance of physical, electrical and chemical properties characteristic of epoxies in an easily handled single-component system. Suitable for low-pressure transfer and compression



Save on utilities and fuel . . . purify process gases using the Hot Carbonate Process with Solvay® Potassium Carbonate. The hot circulating carbonate solution does away with costly heat exchangers and reduces steam requirements.

Wherever conditions of fairly high concentration and partial pressure exist, this is the most economical way to take out carbon dioxide from process gases. Applications range from ammonia synthesis to petrochemicals.

In natural gas treating, it is used to remove *both* carbon dioxide and hydrogen sulfide. Compare the potassium carbonate method's cost and economy with other gas-removal systems.

Mail the coupon below!

Sodium Nitrite • Caustic Soda • Calcium Chloride • Chlorine • Chloroform
Caustic Potash • Potassium Carbonate • Sodium Bicarbonate • Soda Ash
Ammonium Chloride • Methyl Chloride • Ammonium Bicarbonate • Vinyl Chloride
Methylene Chloride • Cleaning Compounds • Hydrogen Peroxide • Aluminum
Chloride • Mutual® Chromium Chemicals • Snowflake® Crystals • Monochlorobenzene • Ortho-dichlorobenzene • Para-dichlorobenzene • Carbon Tetrachloride

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

SOLVAY branch offices and dealers are located in major centers from coast to coast. Send export inquiries to Allied Chemical International, 40 Rector St., N. Y. 6.

Mail to Solvay, without obligation. Check articles desired:

- ☐ "For bulk removal of acid gases . . . Costs Favor Hot Carbonate Process" —Chemical Engineering.
- ☐ "CO_2 Removal from Natural Gas"—Oil and Gas Journal.
- ☐ "Economics of Acid-Gas Removal"—Oil and Gas Journal.
- ☐ "Improved Process for CO_2 Absorption"—Chemical Engineering Progress.
- ☐ "Hot Potash Process for Gas Purification"—Oil and Gas Journal.
- ☐ "Which CO_2 Removal Scheme Is Best?"—Petroleum Refiner.
- ☐ "New Potassium Carbonate Process"—Petroleum Refiner.
- ☐ "Solvay Potassium Carbonate" fact book.

Name_____

Company_____

Address_____

City_____ Zone____ State_____ 14-40

molding, EMC are non-outgassing, self-extinguishing and self-releasing. Their use can lead to large reductions in manufacturing costs, and they are reported to offer a degree of production reliability never before attained.—**American-Marietta Co., Seattle.** 88C

Alumina

Guided missile nose cones made from Al_2O_3 ceramics.

The nose cones pictured above represent a new market for ceramics made from alumina. The material is being supplied by Aluminum Co. of America to a Los Angeles firm for fabrication of the nose cones used on the Navy's Sparrow III air-to-air guided missile. Other ceramic companies are also looking at the oxide for this application on a research and development basis.

Alumina was selected for making the nose cones because of several of its properties. It offers high strength, resistance to shock effects from rapid change in temperature, and resistance to the accelerated-erosion influence which cones are subjected to as they pass through rain clouds at high speeds.

An additional factor in the choice was alumina's uniform transparency to radar waves. This allows the waves to pass to and from the missile's electronic guidance system without distortion. — **Aluminum Co. of America, Pittsburgh.** 90A

1,4-Naphthoquinone

Versatile organic chemical now available in substantially pure form.

1,4-Naphthoquinone, a reactive aromatic with numerous current and potential applications, is now available in 98.5% minimum purity from the intermediates department of American Cyanamid Co. Currently offered in sample quantities, the chemical is to be produced commercially starting early in the second quarter of 1960.

This will mark the first production of a pure naphthoquinone product in this country. In the past, the chemical has been available only as an impure byproduct of phthalic anhydride manufacture.

Pure 1,4-naphthoquinone has been suggested for use as a polymerization regulator for synthetic rubber and polyester resins, and as a stabilizer against the deterioration of transformer oils. It is also reported to be a catalyst for reducing aromatic nitro compounds to the corresponding azo and hydrazo derivatives.

The material is said to be highly reactive, undergoing both addition and substitution reactions with a variety of chemicals at its 2- and 3-positions. Reaction products have found use as dyes, pigments, pharmaceuticals, photographic chemicals, fungicides and in other applications.

For example, 2,3-dichloronaphthoquinone has been suggested as a fungicide and algaecide. 1,4-Naphthoquinone dioxime is a vulcanization agent for butyl rubber, and a polymerization inhibitor and stopping agent for GR-S rubber. Various other derivatives are used to dye nylon, Dacron and cellulose acetate. — **American Cyanamid Co., New York.** 90B

PVC Stabilizers

Three new formulations developed for vinyl processing applications.

Problems in three areas of vinyl processing are said to be alleviated by new special-purpose PVC stabilizers, developed by Ferro Chemical Corp.

Ferro 2035 is for use in calendaring, molding and extruding of plasticized, pigmented vinyls where severe processing conditions are encountered. It is an efficient heat and light stabilizer, providing maximum

Newsworthy Chemicals

For more details, use Reader Service Card

Plastic Film Mulch Speeds Tree Growth

The trees shown above were planted as two-year-olds. They were grown under identical conditions except for the application of a black polyethylene film mulch around the tree in the foreground.

This photographic evidence indicates the results of a preliminary test program at Clayton, N. C., to determine the effect of the mulch on growth of fruit and decorative trees. Tests on a number of tree varieties have shown significantly higher growth rates with the polyethylene treatment.

If broad-scale testing confirms this data, benefits can result for homeowners, nurserymen and fruit growers. — Union Carbide Plastics Co., New York. 92A

resistance to color drift and good long-term heat stability. The material is a white, powdered barium-cadmium formulation supplemented with auxiliary components. It resists roll plateout, is nonpinking in whites and pastels, and is compatible in all calendaring and extrusion compounds under all heat processing conditions.

Ferro 1772 is recommended as a heat and light stabilizer for clear, pigmented and filled plastisol formulations. It has ability to resist plateout or mold deposits, provides long-term light stability, good viscosity control and air release, and is non-sulfur-staining. A liquid, it is a cadmium-zinc formulation containing auxiliary organic stabilizer components.

Ferro 1879L-S comprises a special two-component heat stabilizing system containing barium, cadmium and zinc compounds combined with organics. It is suggested primarily for use in heat stabilization of clear, semi-rigid compounds; however, it may also be used in any plasticized clear or pigmented formulations. In addition to providing good heat stability the system exhibits sulfur stain resistance, and clear semi-rigids stabilized with it will resist the tendency toward early yellowing after exposure to ultraviolet light.—**Ferro Chemical Corp., Bedford, Ohio. 90C**

BRIEFS

Alumina abrasives known as Liquid Sapphire and Liquid Ruby meet requirements of electronic and semiconductor industries, producing ultra-high polished surfaces. Said to assure a new standard of uniform particle size, the material is levigated using deionized, doubly distilled water and packaged in polyethylene to avoid contaminants from glass.—**Geoscience Instruments Corp., New York. 92B**

Irradiated polyolefins are used in formulating Enrad II, a material laminated with glass fibers to form boards for printed circuits. Boards are reported as thin but strong, having outstanding temperature, moisture and dielectric strength characteristics for VHF, UHF uses. — **Enflo Corp., Maple Shade, N. J. 92C**

Phenolic resin is used with woven glass cloth to make a new series of heat-resistant honeycomb core materials for use in aircraft and missiles. Trade-named HRP, the six different core materials range in density from 2 to 15 lb./cu. ft., in cell sizes of ⅛ in. and ⅜ in.—**Hexcel Products Inc., Berkeley, Calif. 92D**

Synthetic latex named Lajax has been developed for use with portland cement in concrete mixes. It is reported to improve adhesion, strength, and shock and chemical resistance, and eliminates need for wet curing and undercutting to secure good bonds.—**Ajax Floor Products Corp., Clifton, N. J. 92E**

For More Information . . .

about any item in this department, circle its code number on the **Reader Service** postcard (p 199)

BRIEFS

13 kinds of caustic potash
an almost totally pure PCl_3
a dependable organic solvent and intermediate

KOH . . . ANY WAY YOU WANT IT!

Name the grade, form and concentration of caustic potash in any combination that fits your process. Ninety-nine times out of a hundred, we can supply it.

You can buy Nialk® caustic potash these *thirteen* different ways:

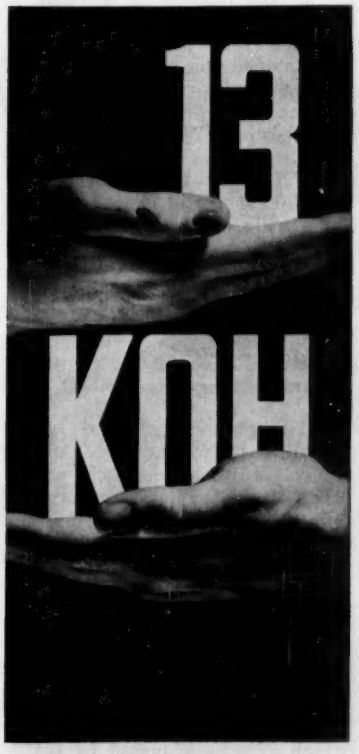
Standard Grades

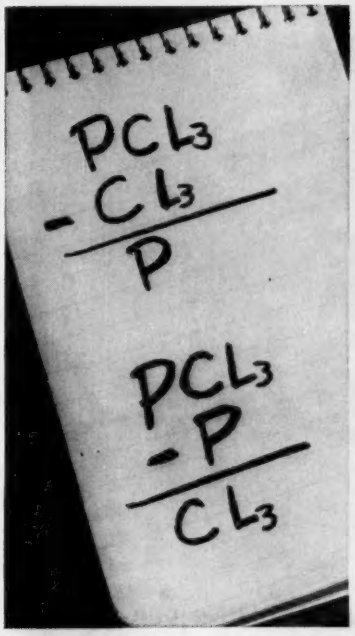
Liquid 45-52%; Solid 90% and 85%; Flake 90% and 85%; Granular, Walnut, Broken, Powder, and Crushed all 90%.

Low-Chloride Grades

Liquid 45-52%; Solid 85%; Flake 85%

A check mark on the coupon will bring you data sheets to help you make your selection.





HOOKER PCl_3 . . . ALMOST TOTALLY PURE

Why settle for less?

You can buy high quality phosphorus trichloride from Hooker at no more than you pay for ordinary brands.

Our product is a water-white liquid that *typically* assays 99.9%. Our specification calls for 99.5% PCl_3 min. and requires a distillation of 97% over a range of 74.5 to 78.0°C.

It contains no free phosphorus.

Use it as a chlorinating agent in making organic acid chlorides, as a condensing agent in preparing organic aldehydes, in making phosphite and phosphonate esters.

Our data sheet gives all the specs. Just check the coupon.

A SPECIAL TRICHLOR . . . NIALK® EXTRACTION GRADE

When you're extracting natural substances like vegetable oils, waxes, animal fats, or botanicals, use a trichlorethylene that really fits your process.

Our Nialk® extraction grade boils between 86.6 and 87.4°C. Its acidity, as a percent of HCl, is zero. Alkalinity, as a percent of NaOH, is only .006 to .008. Free halogen—none. No cloud at minus 12°C.

Moreover, our product meets these specifications *at all times.*

Other uses? Nialk extraction grade makes a flame-proof solvent for adhesives, a dehydrating agent for alcohol, an anesthetic in medicine, an organic intermediate and is used to extract caffeine from coffee.

Check the coupon for data sheet giving full information on specifications, description, and uses.

For more information, check here and mail with your name, title, and company address.

☐ Caustic potash data sheet ☐ Phosphorus trichloride data sheet
☐ Trichlorethylene data sheet

HOOKER CHEMICAL CORPORATION
404 Forty-seventh Street, Niagara Falls, N. Y.

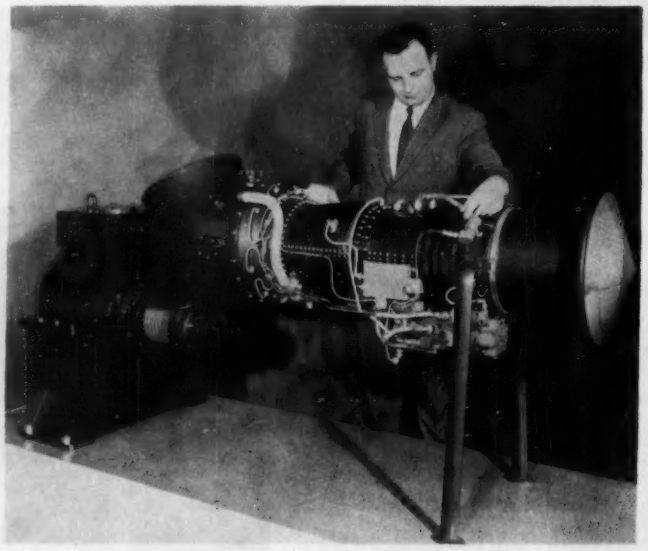
Sales Offices: Buffalo Chicago Detroit Los Angeles New York Niagara Falls Philadelphia Tacoma Worcester, Mass.
In Canada: Hooker Chemicals Limited, North Vancouver, B. C.

HOOKER CHEMICALS PLASTICS

DEVELOPMENTS . . .

PROCESS EQUIPMENT

EDITED BY C. S. CRONAN



Power Package Now Ready to Deliver 900 Hp.

The gas turbine engine above brings to industry a new type of power package derived from a wealth of design experience with airborne units. Complete with reduction gearing, this Model 720/722 engine weighs 1,200 lb., delivers maximum continuous rating of 900 shaft horsepower. Operating on either liquid or gaseous fuel, these engines consume 11,000 Btu./hp./hr., attain 22% thermal efficiency. With basic design already well proved over 6-yr. development for helicopters, these industrial units will undergo evaluation this year on oil-well fracturing and gas-pipeline compressor drive. Along with Model 720/722, GE is offering a Model 240 turbine engine weighing 5,450 lb., without transmission, which is rated for continuous maximum power of 18,300 shaft horsepower. And the company expects soon to complete arrangements for marketing a 75-hp. gas turbine.—General Electric Co., Schenectady 5, N. Y. 94A

Insulated Tank

No external insulation. Very low heat loss.

Developed specifically for outdoor storage, the new Eskimo insulated tank is constructed of reinforced concrete with acid- and alkaline-proof ceramic surfaces, both inside and out. All insulation is located between the walls; there is no outside insulation and weatherproofing to maintain.

While the cost of an Eskimo is slightly higher than that of an uninsulated tank, the differential is offset many times by elimination of the need for tank housing, according to the manufacturer.—**Service & Erection Co., Pittsburgh, Pa. 94B**

Pressure Gages

Corrosion-resisting unit comes in several sizes.

Stainless steel is the material of construction for all components of a new series of drawn-case pressure gages. Each gage meets ASA Grade B specifications, including an accuracy of 2% at the middle, or working half of the scale (3% for the remainder).

Developed for all service involving corrosive atmospheres and media, the gages come in dial sizes of 2, 2½ and 3 in. with pressure ranges to 5,000 psi.—**U. S. Gauges Div., American Machine & Metal Tools, Inc., Sellersville, Pa. 94C**

High-Speed Conveyor

Hurls free-flowing solids into storage containers.

Hurling device, called the "Jetslinger," conveys free-flowing solids into storage bins and other areas, that are otherwise inaccessible. Jetslinger literally slings pelletized or powdered solids as high as 35 ft. above the discharge point and as far away as 90 ft.

Conveyor belts, 14, 20 or 28-in. wide, deliver solids to hurling device at rates up to 700 tons/hr. Rapidly rotating belt hurls solids into a trajectory, which may be adjusted by setting the front pulley.

Jetslinger comes in three

ONE OF A SERIES

Printed by offset lithography on 80-lb. paper containing Wyandotte PURECAL® in the coating.

Why you won't find technical service in the Yellow Pages

WYANDOTTE CHEMICALS

You can't reduce Wyandotte technical service to a few lines of type in the Yellow Pages of a telephone directory.

Even a dozen listings, under a dozen different headings, wouldn't come close to giving you the full picture of what it is and what it can do for you.

You see, Wyandotte technical service is more than a service, more than a department. It's a working philosophy that permeates the entire organization of the Wyandotte Chemicals Corporation.

It's a philosophy whose basic principle is helping our customers get the best possible results from the Wyandotte products they buy.

This broad concept necessarily requires that the functions of Wyandotte technical service cross *all* corporate lines—from research and development and raw material procurement to shipping, storage, and safety.

So, quite naturally, you *won't* find Wyandotte technical service in the Yellow Pages. It's too big for that.

But if you feel that Wyandotte technical service might be able to help you, send us all the information you possibly can on your product or processing problem. Address this data to Technical Service, Wyandotte Chemicals Corporation, Wyandotte, Michigan, and we'll do our best to help you solve your problem.

For a pictorial presentation of Wyandotte technical service at work, please turn page.

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE • MURIATIC ACID • HYDROGEN • DRY ICE
GLYCOLS • SYNTHETIC DETERGENTS • SODIUM CMC • ETHYLENE OXIDE • ETHYLENE DICHLORIDE • POLYETHYLENE GLYCOLS • PROPYLENE OXIDE
PROPYLENE DICHLORIDE • POLYPROPYLENE GLYCOLS • DICHLORODIMETHYLHYDANTOIN • CHLORINATED SOLVENTS • OTHER ORGANIC AND INORGANIC CHEMICALS

Safe handling of Chlorine

. . . an example of Wyandotte technical service at work

1 Wyandotte technical service prepares complete manuals on the safe handling of chlorine . . . recommends equipment for unloading systems, helps in designing new processing equipment, suggests suitable materials of construction, and provides detailed cost estimates.

2 Wyandotte technical service men periodically visit customer installations to inspect handling and packaging of chlorine. Here, a technical service man checks bottling procedures and equipment in a customer's plant to ensure maximum safety and efficiency.

3 Plant personnel get an intensive review of all phases of safe-handling techniques, first-aid measures, and emergency procedures from the Wyandotte technical service man. Wyandotte's excellent safety record in the chlorine industry is the result of continuing vigilance.

4 When the initial tank car of Wyandotte chlorine arrives, the technical service man is on hand to assist in the unloading. He checks the entire operation, making sure all the various safety devices are fully understood. Only then is the Wyandotte chlorine unloaded.

Wyandotte CHEMICALS

Pacing Progress with Creative Chemistry® 832

Wyandotte technical service is with you *every* step of the way when it comes to the safe handling of chlorine. In fact, whatever chemical you buy from Wyandotte, it's the specific job of our technical service department to see that you get the service and technical assistance you need to use the product most efficiently. If you have a problem that falls within our technological or manufacturing background, check with us . . . our approach is designed to provide answers. *Wyandotte Chemicals Corp., Michigan Alkali Division, Wyandotte, Mich. Offices in principal cities.*

for this type service . . . specify this **STRONG** *trap:*

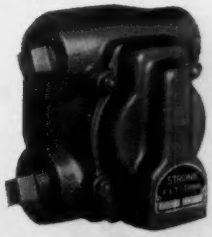
Dirty Lines or Dirty Steam:

Lowest Initial Cost per pound capacity:

Lowest Initial Cost per pound weight:

Eliminating Large Volumes of Air:

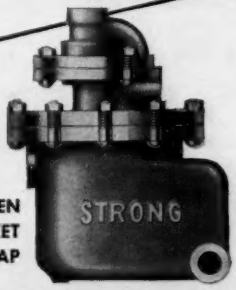
HYDRO-FLEX INVERTED BUCKET TRAP



FLOAT & THERMOSTATIC TRAP

Low Pressures with some air elimination:

Pulsating or Widely Varying Pressures:

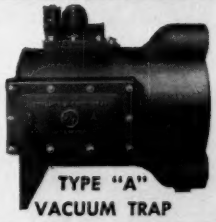


OPEN BUCKET TRAP

Continuous flow required:

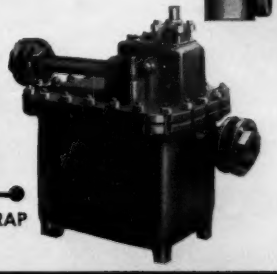
BALL FLOAT TRAP

Draining a line carrying a vacuum discharging to atmosphere:



TYPE "A" VACUUM TRAP

Draining a line carrying a vacuum or very low pressure discharging against a hydrostatic head or back pressure:



TYPE "M" VACUUM TRAP

on every type service

STRONG steam traps give you longer life, less maintenance

Strong offers six types of steam traps to answer every requirement for removing condensate from all types of systems.

You can specify these Strong Traps with the assurance that you will get maximum service life. Proof is the fact that replacement parts are still being ordered for traps sold 50 years ago!

Here are some low maintenance features built into Strong Traps. Screwed-in, replaceable valves and seats of wear-resistant ANUM-METL. Deep-drawn, one-piece stainless steel buckets. Extra-heavy body and cover construction. Thorough testing. Interchangeable parts.

You will be money and years ahead when you specify Strong Traps. For further information, contact your local Strong distributor — he carries complete stocks and replacement parts, offers prompt service.

Selector Chart in Strong Catalog No. 69A gives trap recommendations for 45 types of equipment. Write for your copy or call your distributor.

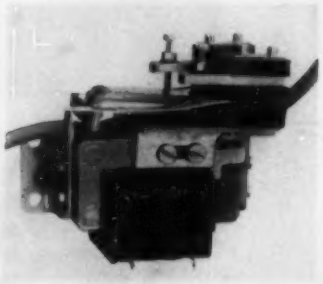
4/S

STRONG, CARLISLE & HAMMOND

508 Sandusky Street • Conneaut, Ohio

steam traps • air traps • float traps • vacuum or pumping traps
F and T traps • continuous blowdown valves • separators • engine stops

models: one that may be suspended from a ceiling, one that swivels on a permanent mount and one mounted on wheels for portable use. One portable model is specially designed for low-head-room service.—**Link Belt Co., Chicago, Ill.** 94D



Laboratory Valve

Remotely controls flow through rubber tubes.

Electromagnetically operated valve accurately meters low-pressure gas or liquid flow through laboratory rubber tubing. Adjustable electric timer or electric relay may send signals to actuate valve opening or closing.

Valve can control flow through tubing up to ¼-in. dia. for pressures up to 10 psi. Valve consumes about 6 w. of 2 to 5-v. ac. or dc. electrical power.—**Milo Mfg. Co., Elizabeth, N. J.** 98A

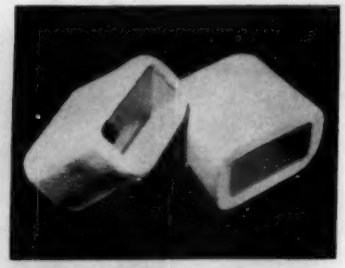
Chemical Treater

No feed components to mix or weigh. Low in cost.

Chemicator, a new equipment item for feeding balanced chemical treating solutions into circulating water systems of cooling towers and evaporative condensers, has been recently placed in national distribution.

Chemicator consists of a small, closed reservoir that is mounted on the side of equipment, through which a portion of recirculating water flows. Primary component of the unit is a sleeve that holds a weather-sealed plastic tube containing a sequence of variously formulated, compressed, chemical briquettes. There are no moving parts.

Of the briquettes, some are polyphosphates and chelates to remove and prevent formation of scale, some are organic corrosion inhibitors to remove and prevent rust, and some are automatic pH, algae and slime controls. Chemicals feed only while the pump is in operation, only when they are needed and at a predetermined rate required for close control. Chemicator equipment sells for about $20.00. — **Erlen Products Co., Burbank, Calif.** 98B



Insulation

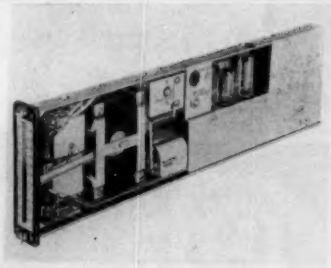
Fibrous potassium titanate takes new insulation forms.

Newly fabricated insulation material offers high thermal resistance and low thermal conductivity up to 2,200 F. High-refractive-index titanate fibers block infrared radiation by diffuse reflectance, thus prevent heat conduction.

Now titanate material, labeled "Resistotherm," is available in rectangular and circular pipe, flat and arched pad, disk and bowl shapes. And titanate is light in weight, with its low density of 16 lbs./cu. ft. —**Resisto Chemical, Inc., Wilmington, Del.** 98C

For More Information

about any item in this department, circle its code number on the **Reader Service** postcard (p. 199)



Ribbon Indicator

Fits in narrow space on graphic panel.

Electronic ribbon indicator measures 2 in. by 5⅞ in., will fit in that limited-size graphic panel. Meter fits onto a single chassis, that may be removed as a unit and mounted vertically or horizontally.

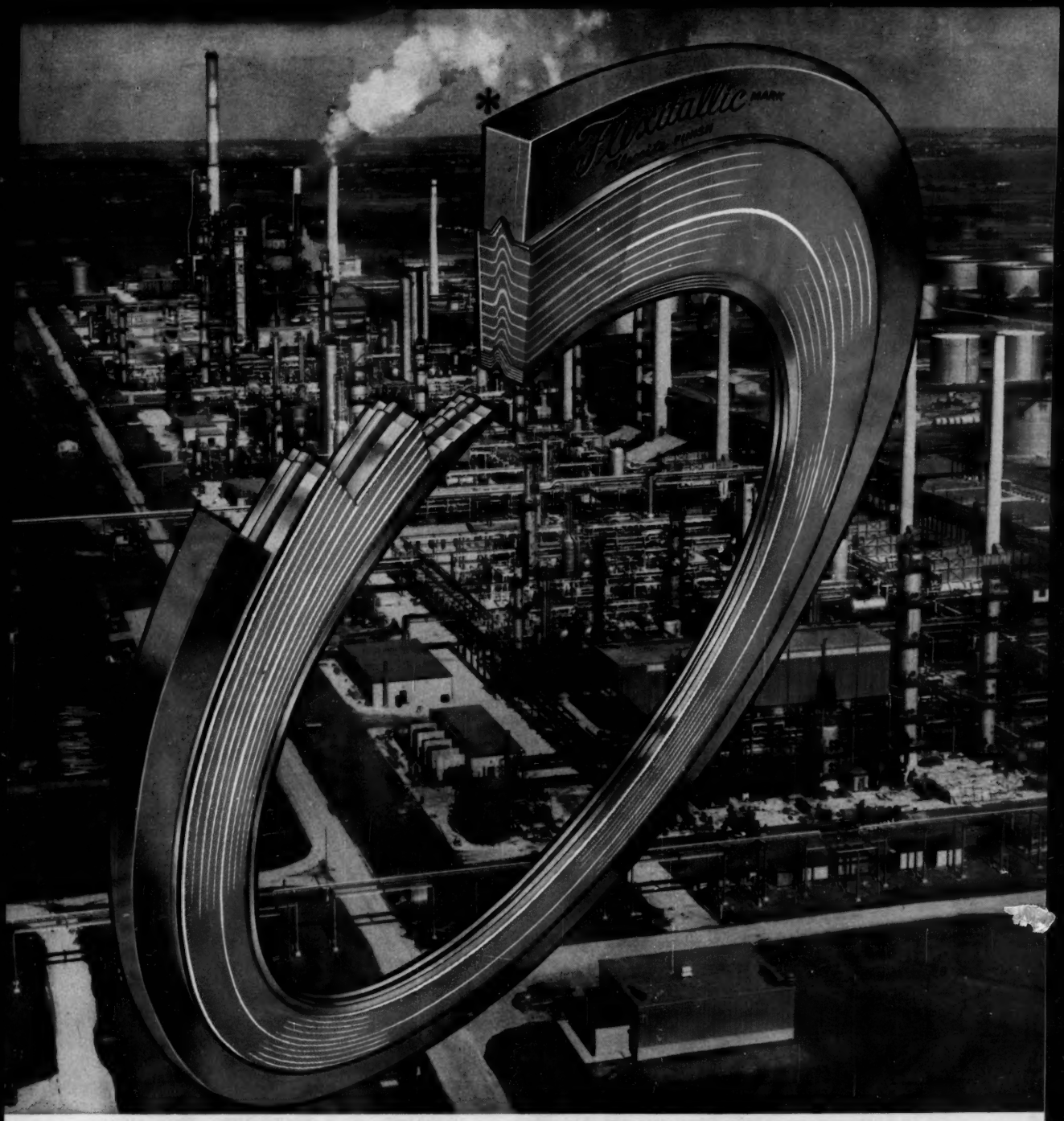
A turn of a screw on the panel front sets zero and span adjustments. Meter automatically disconnects, when removed from the panel.—**Swartwout Div., Crane Co., Cleveland, Ohio.** 98D

Vibrator

Adjustable eccentric varies impact range.

A versatile, explosion-proof, heavy-duty vibrator, designed to move granular and bulk materials safely through bins, chutes, hoppers and other equipment in hazardous locations (Class I, Group D), can be set to produce impacts ranging from 385 to 1,100 lb. When operating, the ER-32 makes no more noise than an electric motor.

ER-32 is totally enclosed and nonvented to assure low maintenance cost. Oversized, heavy-duty bearings require little



End corrosion in gasket inventory

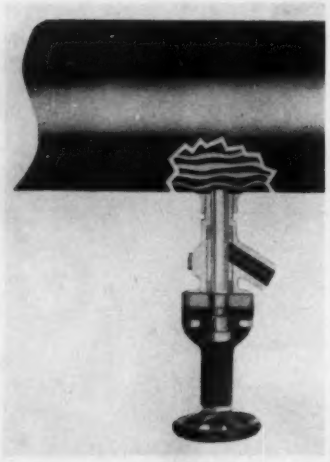
The gold Flexite Finish* for the metal gauge rings in Flexitallic Compression-Gauge Gaskets is new. It is highly corrosion resistant when exposed to severest weathering in open construction projects or in stock. The Flexite Finish provides for ease of identification and a clean, long-lived installation. Write for samples.

FLEXITALLIC GASKET CO., 8th & Bailey Sts., Camden 2, N. J.
Representatives in Principal Cities

TRADE Flexitallic® MARK
SPIRAL-WOUND GASKETS
WITH Flexite FINISH

*The gold Flexite Finish is a development of the Flexitallic Gasket Co. (Originators of Spiral Wound Construction) – Register applied for on both name and color. Flexitallic Blue is our exclusive blue-dyed Canadian asbestos filler. Look for the blue and gold color combination as the mark of Flexitallic quality.

attention, according to the manufacturer. — **Vibro-Plus Products, Inc., Stanhope, N. J.** 98-E



Sampling Valve

Delivers live samples, free of settlement and clogging.

New sampling valve produces live samples, that are unaffected by settling or clogging in the valve body. Stainless-steel valve piston, when in closed position, completely fills the valve body, thus prevents pocketing of solids during ordinary process flow. And when the piston retracts, the entire valve body acts as a channel for free-flowing sample.

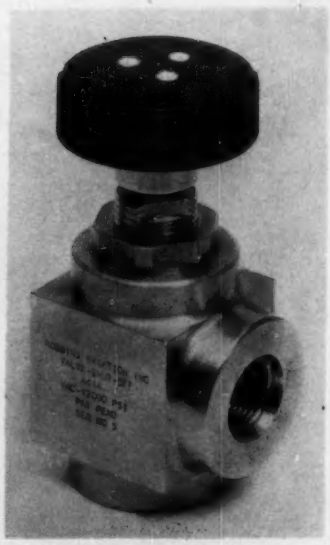
Two Teflon rings, one above the discharge port and the other below, seal the valve for perfect closure. Adjustable packing gland may be tightened to recompress the rings against the piston far more positively than the old-fashioned disk seal. —**Strahman Valves, Inc., Florham Park, N. J.** 100A

Videograph

Decodes and prints computer data for reading.

Newly coupled video camera-digital computer decodes computer pulses and prints answers to research problems in legible type at nearly 20,000 characters/sec. Videograph thus effectively eliminates long research hours, once required to decode taped computer results.

Digital computer output, provided in the form of six on-or-off signals, consists of 64 possible pulse combinations. Videograph's six input signals therefore cause an enclosed electron beam to focus on one of 64 figures; video camera transmits the figure to a viewing screen and printing device. —**Stanford Research Institute, Menlo Park, Calif.** 100B



High-Pressure Valve

Five turns of handle fully controls 12,000 psi.

Known as the Series 400, a new group of pressure-balanced valves require only 30 in.-lb. handle torque to effect a bubble-tight shutoff against 12,000 psi. All functional parts and the forged body are fabricated of stainless steel; all seals are self-energizing, and automatically compensate for wear.

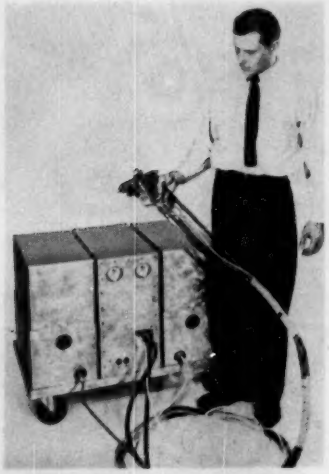
Built for panel mounting, each valve may be completely serviced from the front of the panel without disturbing line connections. Standard temperature range is −65 to 250 F. with ½ in. flow passage and ¾-in. tube port. — **Robbins Aviation, Inc., Los Angeles, Calif.** 100C

Revolving Joint

Flanged sleeve replaces rotating connection.

Newly designed connection for rotary drum journals is simple to service, because hard-to-remove threaded sleeve is eliminated. With new design, rotating drum, dryer or roll connects to the joint by a mounting flange, keyed to the rotating sleeve.

Four simple twists of an end wrench on the mounting flange nuts, loosens the joint sleeve. Design also features self-lubricating bearings and seal, that adjusts itself for wear. New flanged joints are available in 2, 2½ and 3-in. sizes, to handle 200-psi. saturated steam or 400-psi. cold working pressure.— **Barco Mfg. Co., Barrington, Ill.** 100D

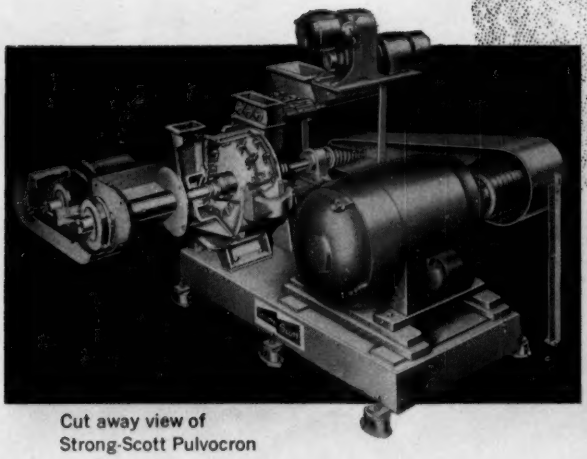


Spray Gun

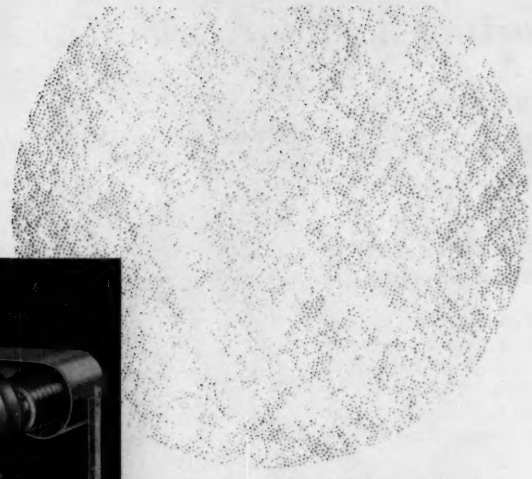
Formulates and sprays polymer coatings.

Turbulator spray gun and polymer formulator permits direct and uniform application of polymer coatings on any indus-

EQUIPMENT NEWS Continues on . . . | Page 188



Cut away view of
Strong-Scott Pulvocron



Magnified Sample of
SITOSTEROLS
Pulverized to
minus 10 microns

Pulverizing with Selective Particle Size Control!

INCREASE PRODUCTION AND CUT OPERATING COSTS WITH THE NEW PULVOCRON

Because this unit is so versatile, it can pulverize hard or soft materials and can operate in the extreme fineness range (95 to 99% finer than 5 to 10 microns) or it can operate in the coarse particle size range (50 mesh and thereabouts).

The Pulvocron is now being used to solve many size reduction problems in the chemical, food and related process industries. Available in 20 and 38-inch grinding chambers and constructed of carbon or stainless steel.

SPECIAL FEATURES

- **Pulverized product particle size control**
- **Pulverized product temperature control**
- **Installation versatility**
- **Accessibility for inspection**
- **Sturdy construction for years of service**

THE PULVOCRON IS AN ADVANCED IMPACT AND AIR ATTRITION PULVERIZER COMBINED WITH INTERNAL PARTICLE SIZE CLASSIFIER.

TYPICAL INSTALLATIONS USING 20″ PULVOCRON

Product	Soya Sitosterols
Feed Material .	40 Mesh (Approx.)
Pulverized . . .	99.99% minus 10 microns
Capacity. . . .	500 lbs. per hr.

Product	Urea Formaldehyde
Feed Material .	¼ to ⅜″ Diameter
Pulverized . . .	99% minus 80 Mesh
Capacity. . . .	1600 lbs. per hr.

Consult Strong-Scott with your pulverizing problems

The **Strong Scott** Mfg. Co.

451 Taft Street N. E., Minneapolis 13, Minnesota • Phone: STerling 1-7461

EQUIPMENT DESIGNED FOR BETTER PROCESSING

Selecting A Motor Drive For A Hazardous Area?

Here's how

TEIGF motors
by E-M

provide safe, dependable, economical power

Faced with the problem of driving hydrogen compressors in atmospheres which might contain hydrocarbons at their Baltimore refinery, engineers of Esso Standard Oil Company turned to TEIGF (Totally Enclosed Inert Gas Filled) Motors. Horsepower requirements exceeded the practicable limits under which explosion-proof motors could be used.

An important consideration was getting the greatest possible drive economy while operating safely in a possible hydrogen atmosphere. Three E-M 350 hp, 390 rpm TEIGF Motors are on duty at Esso Standard Oil Company fulfilling these important qualifications.

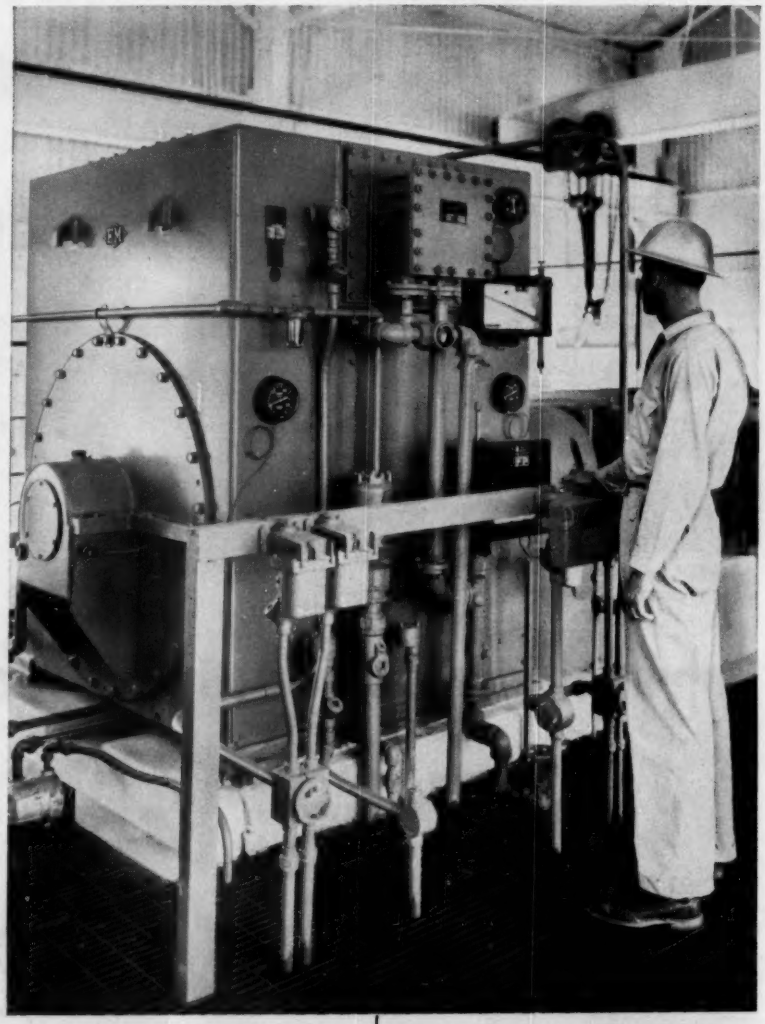
For Esso Standard Oil Company and other companies with similar problems, these E-M Motors offer three main groups of advantages:

1. SAFETY — Within the motor enclosure, inert gas pressure above atmospheric keeps explosive hydrogen *out*. A series of features help accomplish complete safety . . . inert gas pressure gauges . . . temperature gauges . . . purging valves, etc. and a full line of optional equipment. The E-M TEIGF Motor can be "customized" to meet your needs exactly.

2. RUGGED DEPENDABILITY. E-M uses specially designed "box type" frames of heavy-duty plate steel reinforced with heavy bar-stock ribs. They cannot twist or distort. Air gap is accurate and permanent, as all frame welding is completed before precision boring. Ventilating gas passages are carefully engineered to provide unimpeded gas flow for optimum cooling.

3. ECONOMICAL OPERATION. In E-M TEIGF Motors, gas loss is lower than commercially accepted standards. Specially designed shaft seals are oil-pressure gas-sealed bearing type, virtually non-wearing. Where bolts enter outside casing, E-M engineers specify blind holes . . . tapping and drilling are done *into* casing, not through. Operating and maintenance costs are at a minimum.

Consult your nearest E-M sales engineer, or write the factory for TEIGF Motor Bulletin No. 226.



TYPICAL STANDARD FEATURES INCLUDE:

1. Top-mounted gas-to-water cooler for use with suitable cooling water supply.
2. Forced-feed lubricated bearings and oil-pressure gas seals.
3. Oil pump, motor and oil filter. (Can be supplied optionally inside enclosure.)
4. Inert-gas temperature gauge.
5. Inert-gas pressure gauge.

(additional features shown in Bulletin No. 226)

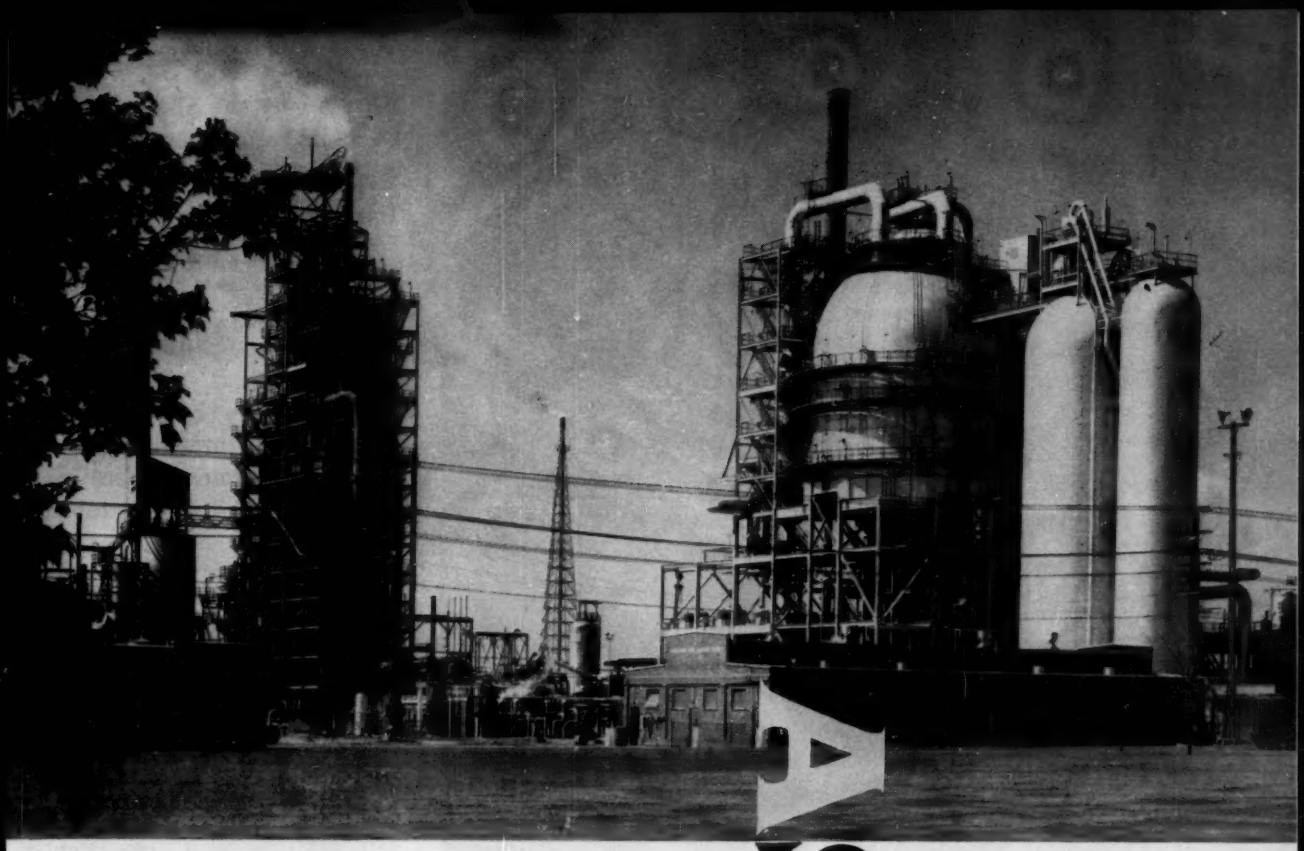
TYPICAL OPTIONAL FEATURES INCLUDE:

1. Water cooler with double-tube construction for added protection against leakage.
2. Liquid level detector switch. Accumulation of moisture within motor sounds alarm or shuts down motor.
3. Bearing temperature relays, to sound alarm or shut down motor.
4. Explosion-proof motor terminal pothead or inert-gas filled terminal box.
5. Water flow indicator. Can be adapted for use with pneumatic-type regulating device.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

E-M
1300—TPA—2179



Low cost, excellent
resistance to corrosion:

FEDERATED CHEMICAL LEAD
sheet, pipe, fittings, linings

Federated lead products are self-healing; malleable, easy to form and bend; salvable with high scrap value; and probably the most efficient protection you can find for many corrosive chemical conditions. These products include chemical lead sheets to your requirements; pipe, bends, traps and standard fittings available from stock; special forms fabricated to order. Write for Bulletin No. 162, the Lead Handbook for the Chemical Process Industries, to Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, RE 2-9500; or call your nearest Federated sales office.

ASARCO

AMERICAN SMELTING AND REFINING COMPANY

FEDERATED METALS DIVISION

Where to call for information:

ALTON, ILLINOIS
Alton: Howard 5-2511
St. Louis: Jackson 4-4040

BALTIMORE, MARYLAND
Orleans 5-2400

BIRMINGHAM, ALA.
Fairfax 2-1802

BOSTON 16, MASS.
Liberty 2-0797

CHICAGO, ILL. (WHITING)
Chicago: Essex 5-5000
Whiting: Whiting 826

CINCINNATI, OHIO
Cherry 1-1678

CLEVELAND, OHIO
Prospect 1-2175

DALLAS, TEXAS
Adams 5-5034

DETROIT 2, MICHIGAN
Trinity 1-5040

EL PASO, TEXAS
(Asarco Mercantile Co.)
3-1852

HOUSTON 29, TEXAS
Orchard 4-7611

LOS ANGELES 23, CALIF.
Angelus 8-4291

MILWAUKEE 10, WIS.
Hilltop 5-7430

MINNEAPOLIS, MINN.
Tuxedo 1-4109

NEWARK, NEW JERSEY
Newark: Mitchell 3-0500
New York: Digby 4-9460

PHILADELPHIA 3, PENNA.
Locust 7-5129

PITTSBURGH 24, PENNA.
Museum 2-2410

PORTLAND 9, OREGON
Capitol 7-1404

ROCHESTER 4, NEW YORK
Locust 5250

ST. LOUIS, MISSOURI
Jackson 4-4040

SALT LAKE CITY 1, UTAH
Empire 4-3601

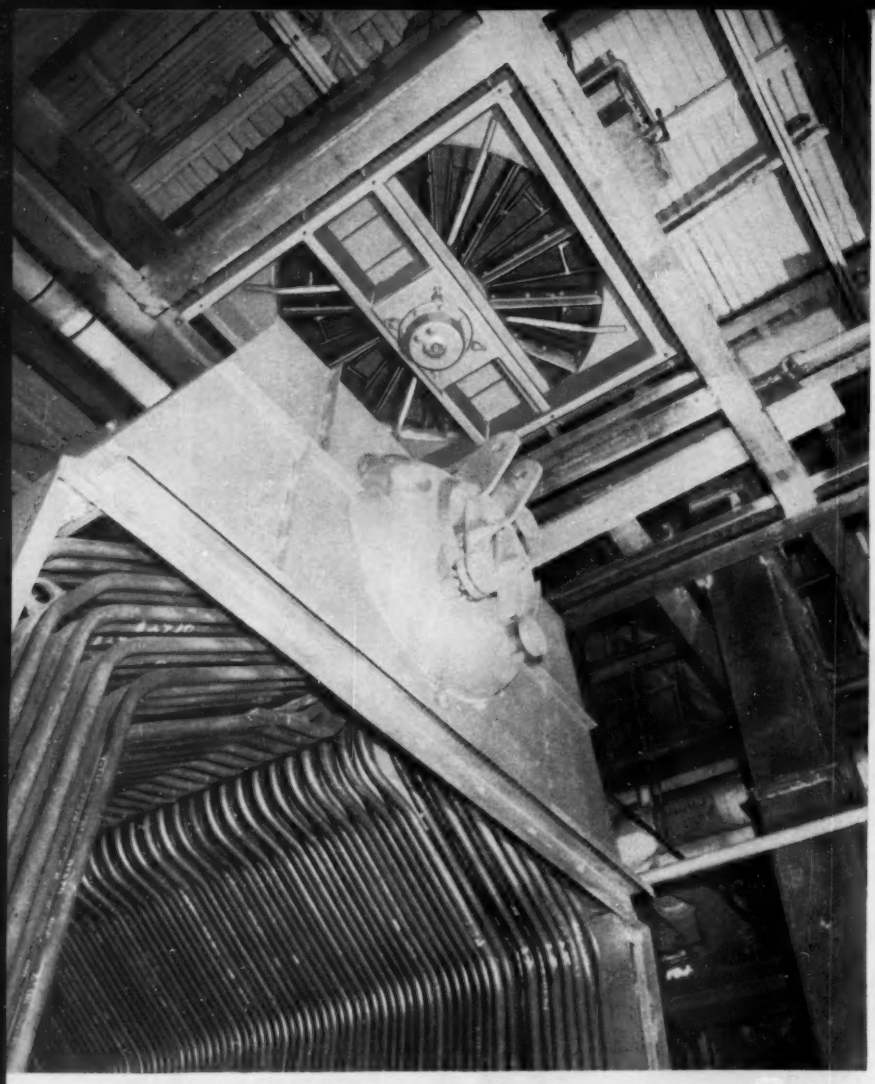
SAN FRANCISCO 24, CALIF.
Atwater 2-3340

SEATTLE 4, WASHINGTON
Main 3-7160

WHITING, IND. (CHICAGO)
Whiting: Whiting 826
Chicago: Essex 5-5000

IN CANADA: Federated Metals Canada, Ltd.
Toronto, Ont., 1110 Birchmount Rd., Scarborough, Phone: Plymouth 73246

Montreal, P.Q., 1400 Norman St., Lachine, Phone: Melrose 7-3591



The Ljungstrom Air Preheater at the B. F. Goodrich Company Shelton Plant is installed directly over the 65,000 lb/hr Wickes boiler. Flue gas leaving the boiler at 615°F passes through the circular rotor, which absorbs the heat and releases it into the incoming air. Preheated combustion air improves combustion, makes fuel burn cleanly. This Package Air Preheater was factory-assembled, and requird only 100 manhours to install.

At B. F. Goodrich Co.'s Shelton Plant

Air Preheater boosts combustion air temperature 345°F... gives 6% more thermal efficiency

"Only a Ljungstrom® Air Preheater, with its continuous regenerative principle, could meet our requirements", says A. G. Sandomirsky, Manager of Engineering at the B. F. Goodrich Company, Shelton, Conn., plant. "We produce foam rubber 24 hours a day, five and six days a week. With an Air Preheater we can meet process steam requirements more economically, and an Air Preheater helped us to justify the installation of high efficiency, high pressure equipment for by-product power generation."

Here's why the Shelton plant meets its requirements best with a Ljungstrom Air Preheater:

1. Ljungstrom is the most efficient heat exchanger you can buy. The Ljungstrom rotor revolves continuously through the flue gas and incoming air, thus absorbing heat and releasing it *from the same surface*. Since the heat doesn't have to pass through anything, each inch of rotor surface is as efficient as one foot of a tubular recuperator.

2. Ljungstrom is the most reliable heat exchanger you can buy. All heat exchange elements pass through the entire air and gas streams. The temperature of the elements in the coolest region – where fresh air enters – is actually an average of the gas and air temperatures, so it's consistently higher than the coolest point in a recuperative heat exchanger. Result: no cold spots, less chance of moisture formation.

3. Ljungstrom is easiest to maintain. You can inspect it – and clean it–while it's running. Heat exchange elements are divided into modular baskets that can be replaced individually without disturbing the other elements. You can even reverse the elements if the surface has thinned on one edge, effectively doubling the life of the heat exchange surface.

For more information on the Ljungstrom continuous regenerative principle, or on the Air Preheater that meets your requirements, phone MUrray Hill 2-8250 or write to The Air Preheater Corporation.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

Tune up furnaces with dashboard simplicity Using a Bailey HEAT PROVER Analyzer

• For fast accurate combustion analysis, compare this portable unit to Orsat measurements: It tells you **what's happening** as you make furnace, kiln, or engine adjustments, **not what happened!** No guessing, no spot readings to average. Simple, convenient to use.

The continuous readings from a Bailey HEAT PROVER Analyzer enable operators to correct combustion variables before costly losses are incurred. The two meters on the analyzer show per cent by volume of oxygen and combustibles on either a 20% range span or a more sensitive 4% range. Temperature of the gases in degrees Fahrenheit may also be shown.

To order or get additional facts, write us direct or contact any of our District Offices. You'll find them listed in Chemical Engineering Catalog, Refinery Catalog, Thomas Register, or Mechanical Catalog.

Gas analysis with Bailey **HEAT PROVER** Analyzer at a process heater. Per cent oxygen and combustibles is shown continuously while testing.

CP106-1

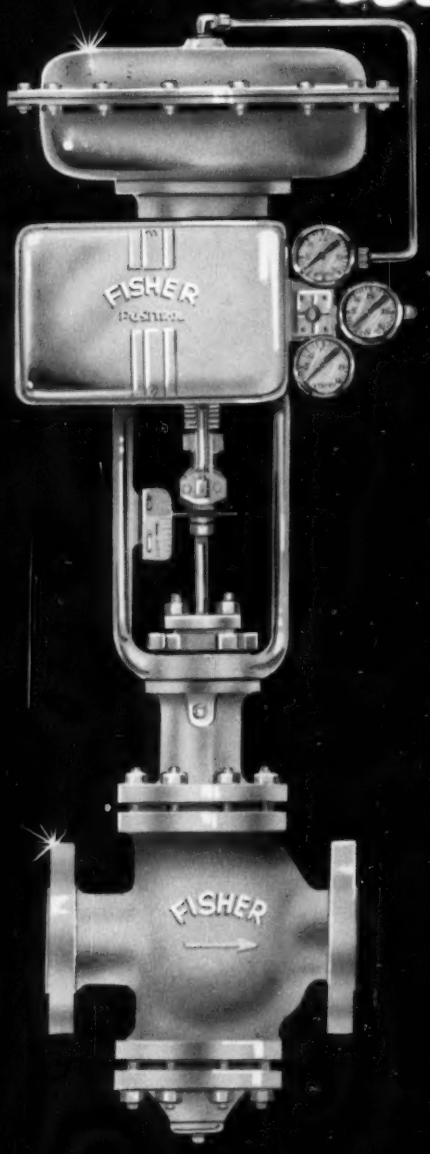
Chemical and petroleum division

BAILEY METER COMPANY

1054 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

. . . not even 24k GOLD . . .



why you can depend on

FISHER CONTROL VALVES

24 hours a day –every day. .

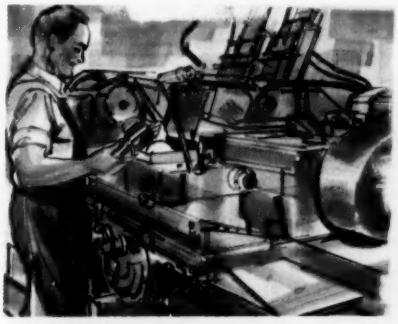
. . could increase the value of a FISHER DMV!

Why? Simply because the *real* value of Fisher diaphragm motor valves lies, not in metal and fiber and paint. It lies in practical design, improved manufacturing techniques, rigid inspection and a field organization second to none.

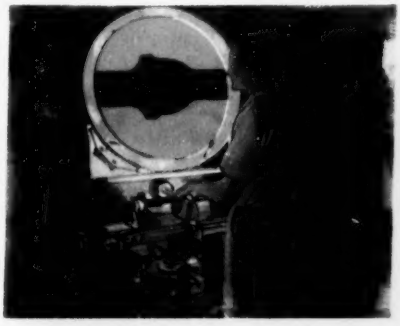
These are the factors that represent your real assurance of trouble-free performance in Fisher control equipment. They are also the factors that have made Fisher control valves the standard throughout industry for nearly half a century.

Next time you need control valves give the Fisher/Man a call. He's conveniently located for service and you'll find he has what you want . . . and where you want it . . . in a hurry.

PRACTICAL DESIGN ENGINEERING
Design Engineering at Fisher is always aimed t solving industry's flow control problems in practical and efficient manner. Continuous mprovement for more than 50 years has re-ulted in a series of Fisher Diaphragm Motor Valves of proven durability and performance.



LATEST PRODUCTION METHODS
This machine, the latest in precision grinders, produces a super-finish on all valve guides and bushings. It is just one example of combining modern machine tools and the skill of experienced Fisher craftsmen to assure accuracy of control and long, trouble-free field operation.



RIGID INSPECTION PROCEDURES
Fisher's ratio of inspection personnel to production personnel has always been considered highest in the industry. This makes possible Fisher's rigid inspection policies. For example, no less than 704 inspection operations are performed on a 4" Type 657A control valve.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / Rochester, England

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIP. CO., CORAOPOLIS, PA.

FISHER® Controls

SINCE 1880

Steam trap dependability is a matter of what the manufacturer puts into the trap

ARMSTRONG TRAPS ARE DESIGNED AND MADE TO GIVE YOU DEPENDABILITY

1. Efficient, proved operating principle

Armstrong Traps provide the most advanced development of the time-proven inverted bucket principle. Simple, but effective, there isn't much that can go wrong.

2. Good design

Armstrong Trap design gives big capacity in a small package. The mechanism is virtually fool-proof. All body styles are easy to inspect and maintain without removal from the line.

3. Highest quality materials of construction

Only the best goes into Armstrong Traps. Bodies are close grained 30,000 tensile iron castings or high quality forgings. Working parts are all tough, corrosion resistant stainless steel.

4. Good workmanship

Armstrong Traps are made by craftsmen who take pride in their work. Careful inspection and frequent checking insure the quality of the trap.

5. Application know-how

Your problem has probably been solved already in the extensive experience of the Armstrong engineering and sales organization. You can be sure of sound, dependable recommendations.

Your local Armstrong Representative can show you what Armstrong dependability can do for you. Call him today or write direct.

860 Series for low pressure heating service.

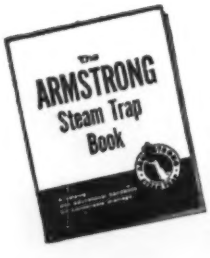
800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.



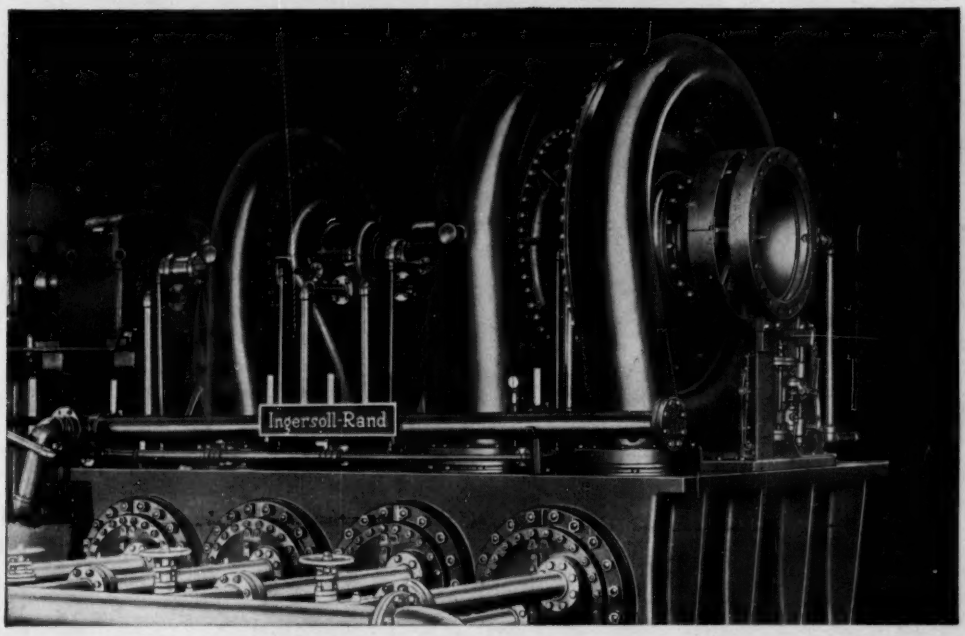
The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

8588 MAPLE STREET THREE RIVERS, MICHIGAN

See our catalog in "Chemical Engineering Catalog."

ANOTHER **NEW DEVELOPMENT** FROM INGERSOLL-RAND



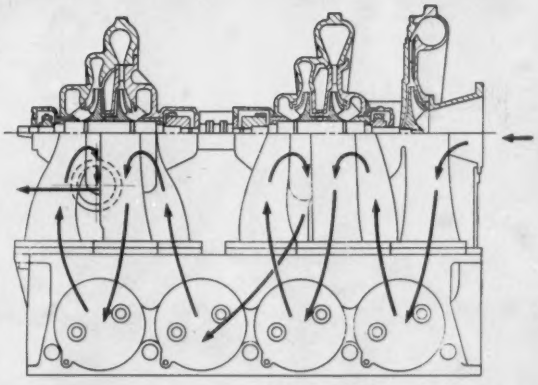
New 100 psi Centrifugal Air Compressor delivers up to 35,000* cfm

Five-Stage Intercooled Unit provides new efficiency and economy, with big savings in space and weight

THE Ingersoll-Rand CVM Centrifugal Compressor represents a new concept in the efficiency and economy of large-capacity air compression in the 100-125 psi range. With five compression stages and intercooling between each stage, it approaches the ideal *isothermal design*, delivering more air per horsepower than any other type of multi-stage centrifugal compressor.

The five impellers are mounted on two shafts, with two impeller pairs back-to-back to minimize axial thrust. The short shaft construction permits operation below first critical speed, minimizing vibration and extending the life of bearings and seals. The water-cooled intercoolers are integral with the machine base, have all water connections on the same side, and can be cleaned while the compressor is in operation.

The CVM Centrifugal Compressor is available in ratings to 35,000 cfm for discharge pressures to approximately 125 psi. For further details, see your I-R representative or write to Ingersoll-Rand.



Side elevation drawing of a CVM Centrifugal Air Compressor with top half of casing sections cut away to show impeller arrangement. Arrows indicate air flow through impellers and intercoolers.

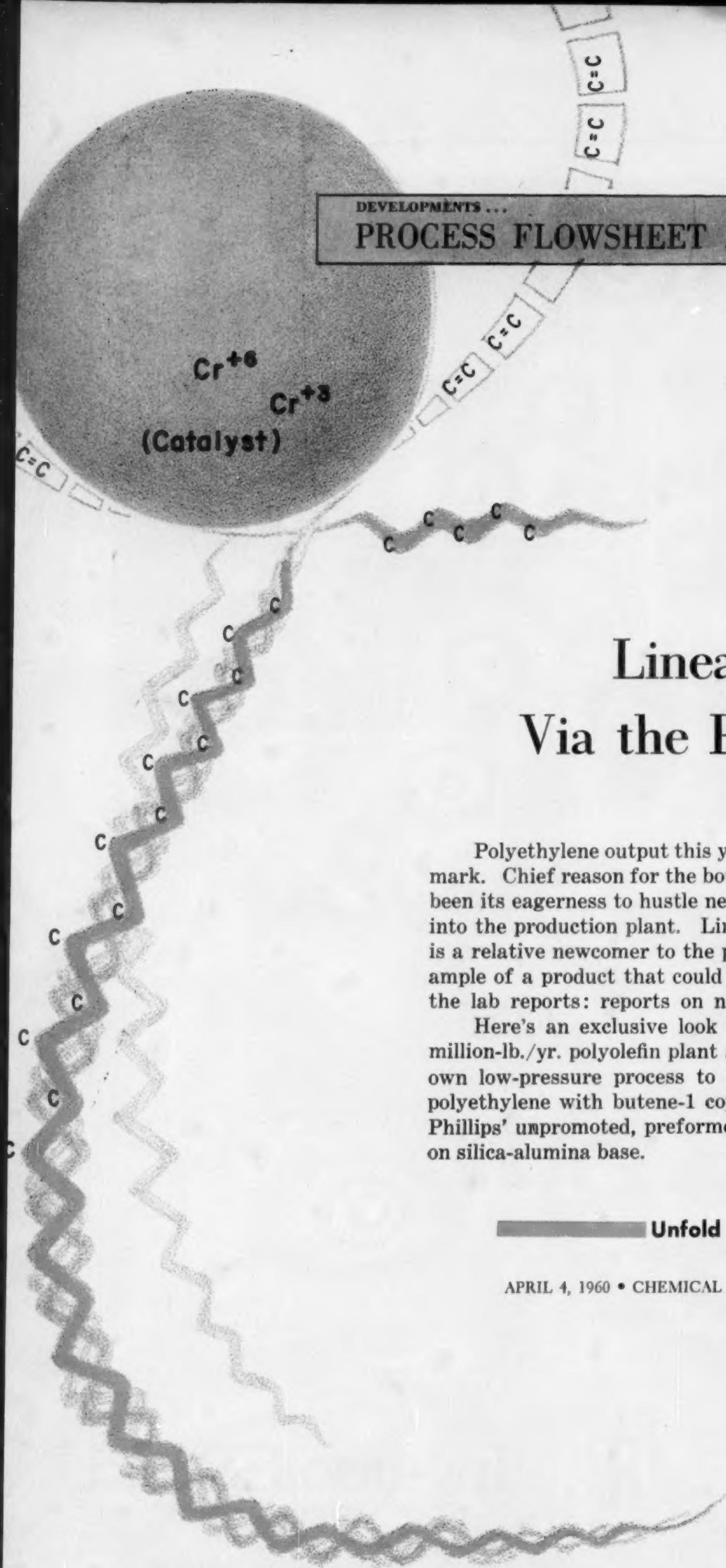
Ingersoll-Rand

12-988 11 Broadway, New York 4, N. Y.

**Higher capacities available with other designs.*

COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

 J. B. BACON



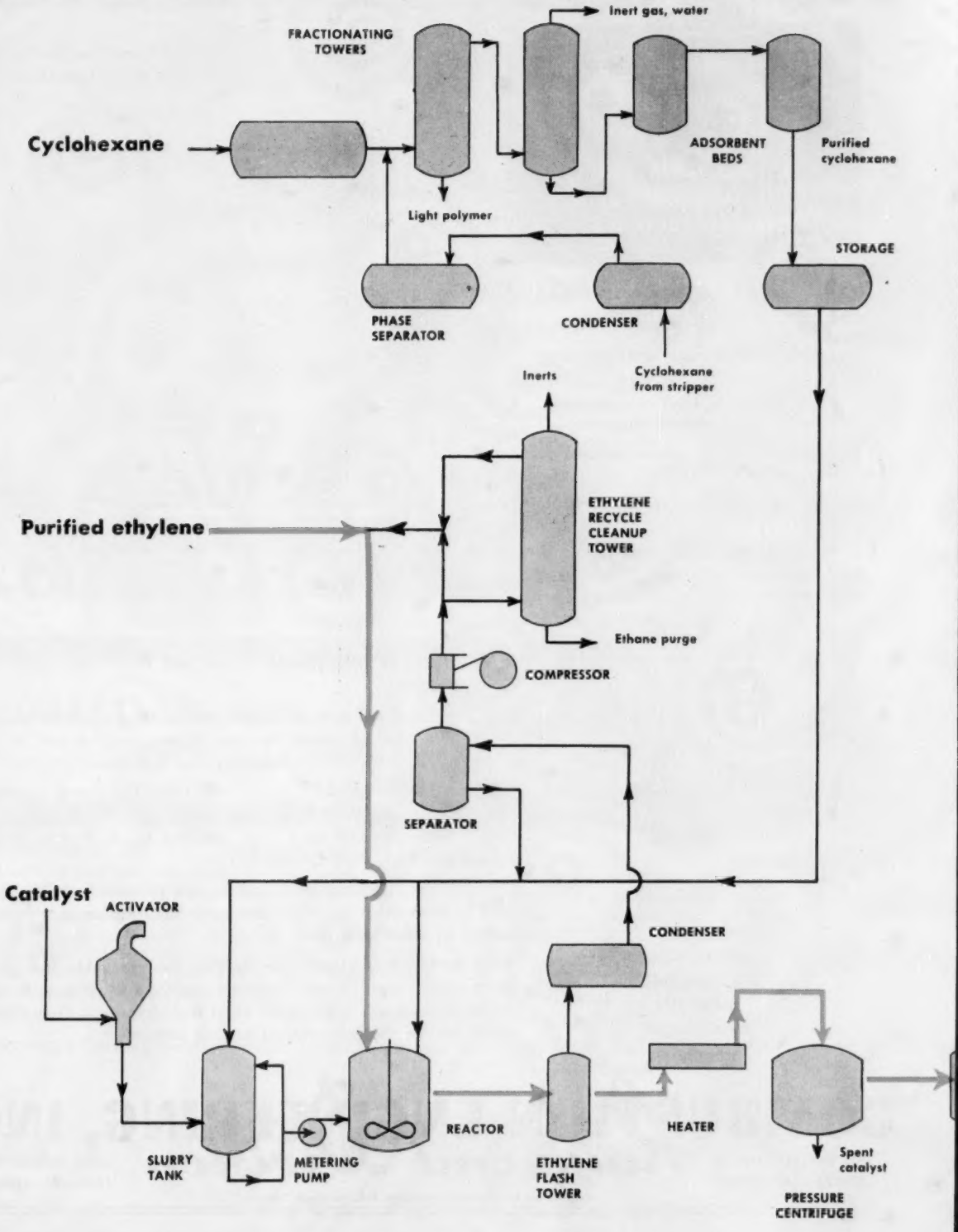
Linear Polyethylene Via the Phillips Process

Polyethylene output this year should pass the 1-billion-lb./yr. mark. Chief reason for the bounding growth of this industry has been its eagerness to hustle new technology out of the laboratory into the production plant. Linear, or high-density, polyethylene is a relative newcomer to the plastics field. And it's a prime example of a product that could hardly wait for the ink to dry on the lab reports: reports on new solid polymerization catalysts.

Here's an exclusive look inside Phillips Chemical Co.'s 75-million-lb./yr. polyolefin plant at Houston, Tex. Phillips uses its own low-pressure process to turn out linear polyethylene and polyethylene with butene-1 copolymer. Heart of the process is Phillips' unpromoted, preformed solid catalyst—chromium oxide on silica-alumina base.

Unfold Flowsheet →

APRIL 4, 1960 • CHEMICAL ENGINEERING • PAGES 110-113


Inert gas, water
FRACTIONATING TOWERS
Cyclohexane
ADSORBENT BEDS
Purified cyclohexane
Light polymer
STORAGE
PHASE SEPARATOR
CONDENSER
Cyclohexane from stripper
Inerts
Purified ethylene
ETHYLENE RECYCLE CLEANUP TOWER
Ethane purge
COMPRESSOR
SEPARATOR
Catalyst
ACTIVATOR
CONDENSER
SLURRY TANK
METERING PUMP
REACTOR
ETHYLENE FLASH TOWER
HEATER
Spent catalyst
PRESSURE CENTRIFUGE

Low-pressure processes turn out polyolefins that are harder, less permeable, higher-melting and of higher density than polymers produced commercially by high-pressure routes.

▶**Purify, Then React**—Ethylene for Phillips' plant comes 80 mi. by pipeline from the firm's Sweeny, Tex., refinery. Butene-1 and cyclohexane solvent are brought in by tank car. Catalyst is produced to Phillips' specifications by an outside company.

After purification, monomer (or monomers) and catalyst feed continuously to a reactor operating at about 400 psig. and 300 F. According to one literature source, catalyst slurry enters the reactor with about 1.0 wt.% catalyst. Cyclohexane acts both as carrier for polymer and as heat-transfer agent.

▶**What's Known and What's Not**—In a solution process such as Phillips', polymerization occurs on the catalyst surface, but polymer dissolves as soon as it forms. In general, molecular weight of the polymer increases with pressure and with decreasing reactor temperature. However, it decreases with increasing catalyst-activation temperature.

Several mechanisms have been postulated for 1-olefin polymerization on preformed catalysts. Eirich and Mark propose that the Phillips catalyst acts as a Lewis acid, and that the reaction involves donation of electrons from the monomer to the *d* shell of the chromium. Electrons are subsequently returned in the course of polymerization.

▶**Remove Monomer and Catalyst**—Polymer solution from the reactor passes to a flash tank which removes unreacted ethylene and recycles it to reactor, either after simple separation or after routing through a cleanup fractionator to remove inerts.

Catalyst separates from solution in a pressurized, disk-type, nozzle-bowl centrifuge. Bowl of the centrifuge spins at more than 2,000 rpm., develops a force of about 2,000 G's. Catalyst content of polymer overflow is below maximum specification of 8 ppm. Filters assure maximum-quality product.

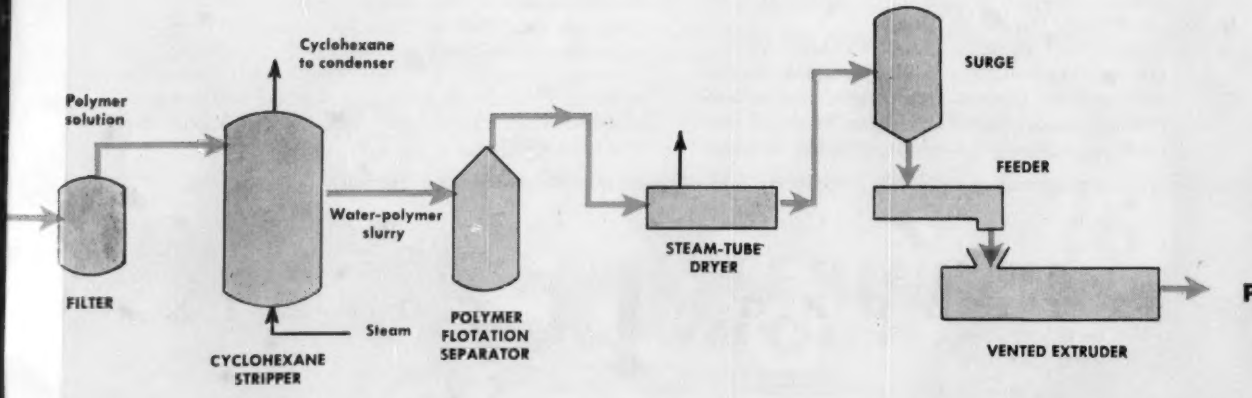
▶**Precipitation Is Sticky**—Polymer precipitates from solution by cooling with addition of water. Steam stripping removes cyclohexane solvent.

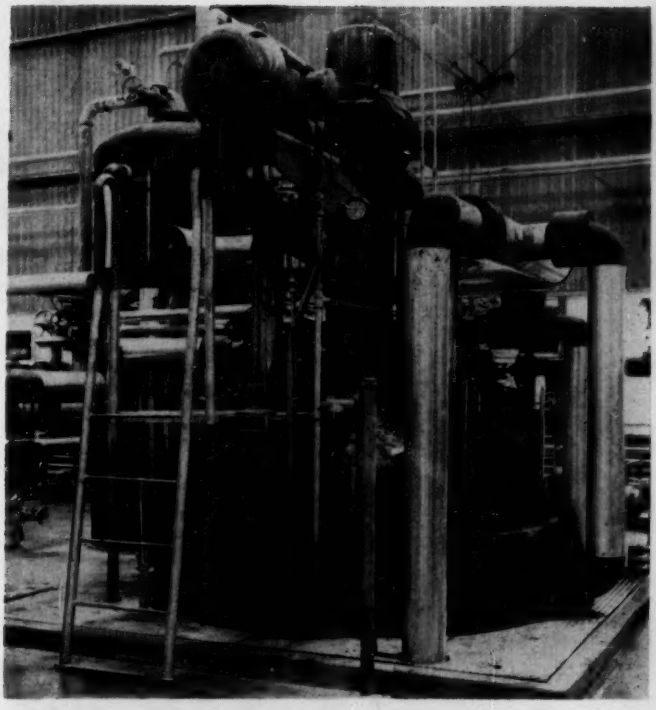
In this step, polymer must pass from solution to water slurry through a sticky intermediate stage. Phillips tried several designs of solvent-removal step before developing a reliable continuous system.

After stripping, polymer is skimmed from water and passes through a rotary steam dryer which reduces moisture below 2%. Polymer is now in the form of dried crumb.

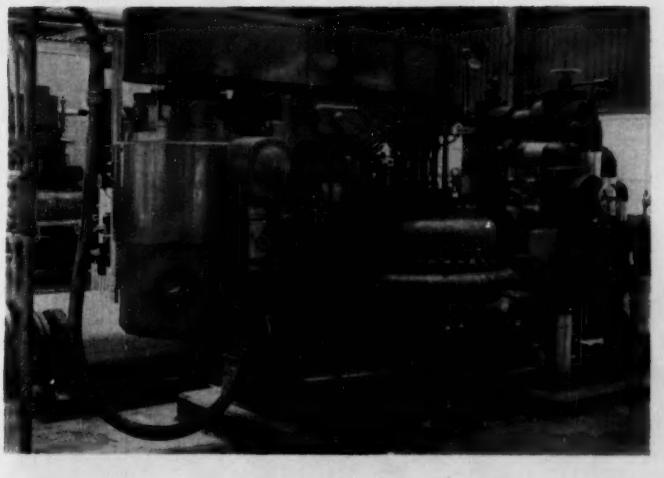
Water and cyclohexane from the steam stripper are condensed and separated. Hydrocarbon phase goes through fractionators and absorbent beds to remove light polymer and water before returning to the system.

Dried crumb is conveyed to extractor-extruders where remaining moisture is removed at the same time antioxidants are added. Extruders turn out molten strands of polymer which are chilled in a water bath and chopped to proper size. Finished polymer is blended and bagged for shipment.





REACTOR receives ethylene, solvent, catalyst, polymerizes monomer at about 400 psig., 300 F. Catalyst-solution slurry then passes to flash tower which removes unused monomer.



PRESSURE CENTRIFUGE develops force of 2,000 G's, removes catalyst from polymer solution.

EXTRUDERS, where antioxidant is added, press out strands of polymer which cool in water bath.

Polyethylene

accuracy

ASHCROFT DURAGAUGES measure pressure with precise accuracy no matter how severe the conditions of service

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".

sustained

The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

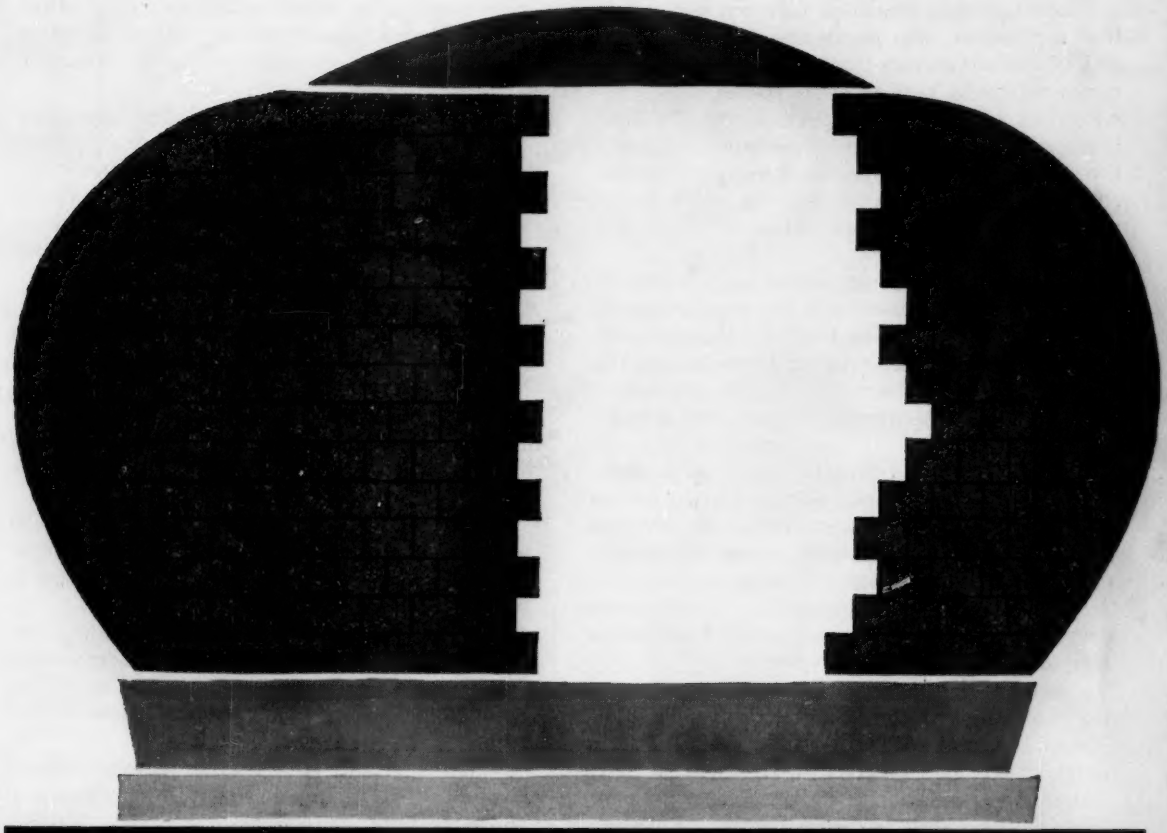
The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario



FOAMGLAS® Insulation works for GULF

EVIDENCE: Back in 1951, Gulf Oil Corporation insulated four Hortonspheroids at the Port Arthur Refinery with FOAMGLAS—to help hold stored butane at 50°F. See how well FOAMGLAS worked.

Gulf reports that moisture-proof FOAMGLAS has maintained constant insulating value throughout the last nine years—to help prevent butane evaporation loss despite external temperature fluctuations. With the special application techniques used in applying FOAMGLAS, corrosion problems have been minimal and maintenance minor, since moisture can't get through the insulation to attack Gulf's spheroids' walls.

Get all the details and see for yourself. Write today for our Gulf Case Study report and your free copy of our Industrial Insulation Catalog. Pittsburgh Corning Corporation, Dept. H-40, One Gateway Center, Pittsburgh 22, Pennsylvania. In Canada: 3333 Cavendish Boulevard, Montreal, Quebec.

Pittsburgh Corning makes available a complete line of insulation accessories for use with FOAMGLAS.

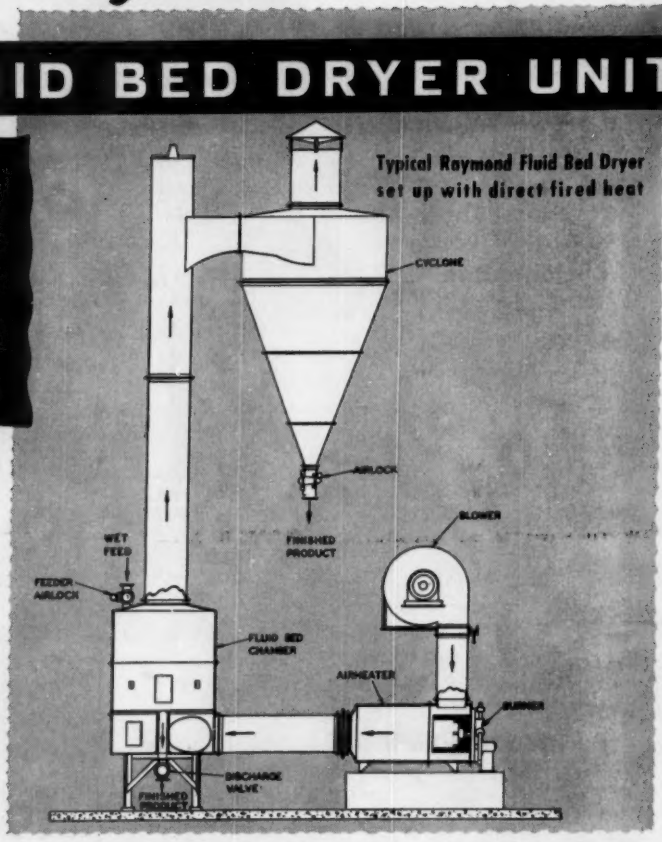
PITTSBURGH PC CORNING

Note this NEW Raymond

FLUID BED DRYER UNIT

Recent addition to the Raymond line of Drying Systems.

Now available for the processing of various special products.



Typical Raymond Fluid Bed Dryer set up with direct fired heat

PRINCIPAL ADVANTAGES

1. High thermal efficiency
2. Small space requirements
3. Absolute minimum of moving parts (none in high temperature zone) helps to reduce maintenance
4. Gentle handling gives minimum degradation
5. Permits some degree of particle size classification
6. Accurate control of final H_2O
7. Continuous, automatic, dust-free operation

You will want to read about this new process.

WRITE FOR RAYMOND BULLETIN eighty-eight

Raymond started development work on the Fluid Bed type of dryer in 1950 as a complement to the well known line of Flash Drying Systems.

This broadened the range of dryers for handling problems where a very minimum of crystal breakage is required, as well as in processes where appreciable retention time is desired.

The first commercial size Raymond Fluid Bed Dryer was installed in 1953 on a problem requiring minimum crystal breakage. Since then, additional units have been installed by themselves or in conjunction with Flash Drying Systems.

Salt, gilsonite, synthetic resins and organic crystals are being handled in these units. Successful test work has been conducted on a variety of other materials.

With the broadened line of drying units now available, is it even more important to consult Raymond engineers when your drying problems come up. A Raymond Fluid Bed Dryer or a Flash Dryer could well be the best solution to your problem.

COMBUSTION ENGINEERING, INC.
Raymond Division
1112 W. BLACKHAWK ST.
CHICAGO 22, ILLINOIS
SALES OFFICES IN PRINCIPAL CITIES
Combustion Engineering-Superheater Ltd., Montreal, Canada

for butane, propane and ammonia service

Photos of propane installation at Caterpillar Tractor Co., Aurora, Illinois. RegO-equipped by Fergeson Co., Cleveland, Ohio

most complete line in the industry

In applications where safety and performance are of first importance, engineers recognize and appreciate the value of a single, completely dependable source of equipment. RegO for over forty years has been the world's leading manufacturer of the myriad varieties of valves, manifolds, regulators and other fittings used in butane, propane and anhydrous ammonia service. Skillful design, thorough assembly-line testing at design-working-pressure, and 100% final inspection means that when you specify RegO you're doubly sure of proven performance...both when it's installed and for the years to come!

TYPICAL REGO EQUIPMENT FOR LP-GAS AND ANHYDROUS AMMONIA:

ALSO REGO HIGH PRESSURE GAS CONTROL EQUIPMENT:

WRITE FOR FREE CATALOGS ON THE TYPE OF EQUIPMENT YOU NEED

- ☐ L-100 for Butane, Propane
- ☐ A-100 for Anhydrous Ammonia
- ☐ G-300 for High Pressure Gases

The BASTIAN-BLESSING Company
4201 W. Peterson Avenue
Chicago 46, Illinois, Dept. 22-D

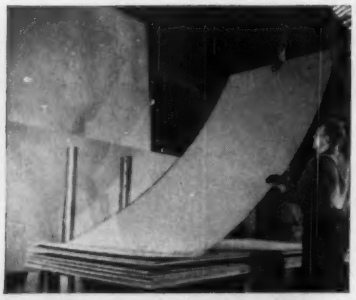
STAINLESS DIRECTORY

Buyers Guide to Ryerson Stainless Stocks & Services

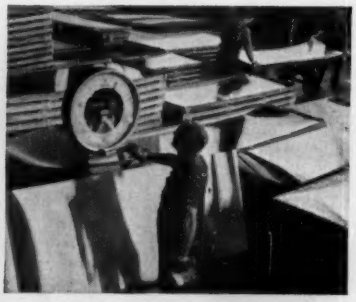
Here's a quick guide to the nation's largest stocks of stainless steel. This wide selection assures you of getting the best stainless for every application.

Extra care in storage, handling and shipping guards the high quality of Ryerson stainless stocks. For example, shear clamps are padded to protect the fine finish and flatness of sheets. And in addition, the help of experienced stainless specialists is yours when you call Ryerson on problems of application or fabrication.

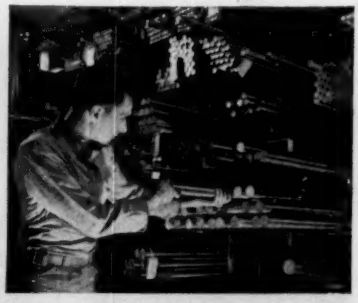
See your Ryerson catalog for a complete listing of stainless stocks and call your nearby Ryerson plant for immediate shipment.



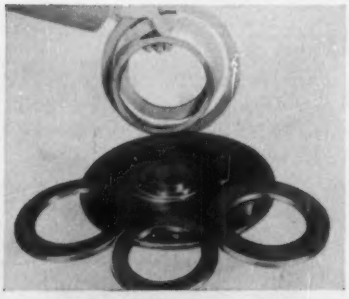
PLATES—Available in 9 analyses including plates to Atomic Energy Commission requirements and to ASTM specifications for code work. Also low carbon types for easy welding.



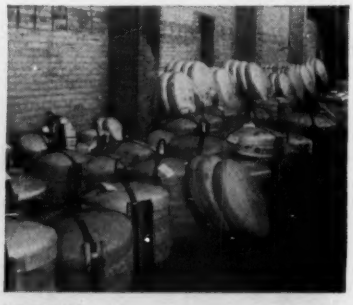
SHEETS—11 analyses of Allegheny stainless sheets in stock including nickel and straight chrome types. Also extra wide sheets to reduce welding costs, expanded and perforated sheets.



BARS AND ANGLES—Rounds, squares, flat's, hex's and angles in 8 types including free-machining bars with both analysis and mechanical properties controlled.



RINGS AND DISCS—Machine cut to your order. This service assures size accuracy, smooth edges, flatness and unaffected corrosion resistance in a lower-cost, ready-to-use product.



HEADS—A.S.M.E. flanged and dished heads in types 304, 304L, 316 and 316L are on hand in large quantities, and in a wide range of gauges and sizes.

PIPE AND TUBING—Light wall, standard and extra heavy pipe, ornamental and regular stainless tubing. Also screwed type and welding fittings and Cooper stainless valves.

METALOGICS

STEEL • ALUMINUM • PLASTICS • METALWORKING MACHINERY

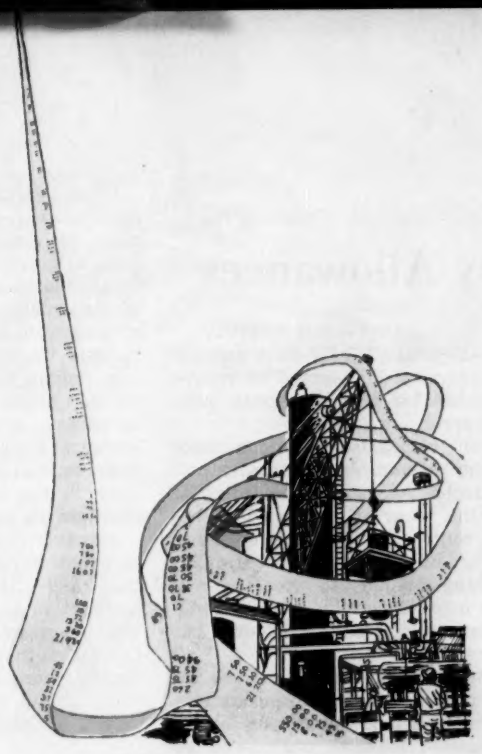
RYERSON STEEL®

Joseph T. Ryerson & Son, Inc., Member of the INLAND® Steel Family

PLANT SERVICE CENTERS: BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DETROIT • HOUSTON • INDIANAPOLIS
LOS ANGELES • MILWAUKEE • NEW YORK • PHILADELPHIA • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SPOKANE • WALLINGFORD

Chemical Engineering

APRIL 4, 1960



Estimating Methods

For Process Industry Capital Costs

JOHN W. HACKNEY, Beaco, Ltd., Montreal, Que.*

GOOD estimating requires prior preparation of reliable cost data and development of satisfactory procedures. By selecting suitable combinations of these data and procedures, we can prepare estimates having the optimum degree of accuracy for a specific stage of project development.

In Part I (*Chem. Eng.*, Mar. 7, 1960) of this two-part report, we developed methods of establishing estimating data sources for equipment, labor and material and provided an analysis of design and field expenses.

In this part of the report, we'll complete the basic data by showing why contingency allowances are necessary and how to prepare and make uncertainty ratings for process-plant projects.

Having established all of the basic estimating procedures, we can apply them to make estimates by the following methods:

- Equipment ratio method
- Layout method
- Preliminary bill method
- Detailed unit cost method

Each of these methods gives estimates having different ranges of accuracy when compared to actual installed cost of a project. On projects under construction, periodic re-estimates based on these methods improve the accuracy of final estimated cost. Re-estimates also provide control over expenditures for project costs including labor and materials.

Each estimating method will require project and cost data commensurate with its range of accuracy. Of course, time and cost of making the estimate will depend on the estimating method chosen.

* To meet your author, see *Chem. Eng.*, Mar. 7, 1960, p. 130.

Provide Contingency Allowances

Contingency allowances can be included in cost estimates to compensate for accidental events, changes in general economic conditions, errors, imperfections of estimating methods and oversights.

Accidental Events

Most accidental events can be neutralized by insurance. For example: fires, construction accidents, floods, explosions, wind-damage can be insured against and the premium made part of the job cost.

Some accidental events such as those encountered in underwater work can be covered by a contingency item. Where possible, it is better to allow for accidental events by paying insurance premiums than by contingency allowances.

Economic Conditions

Forecasting changes in general economic conditions is very difficult. In spite of years of study by statisticians and the expenditure of tremendous sums of money by governmental agencies, there is still no reliable means for predicting major changes in either the national economy or the construction industry.

These problems are so important that we cannot avoid them. If we could forecast construction volume, we might also be able to forecast some of the effects of volume which are not indicated by the usual construction cost indexes. Indexes are usually based on published prices and wage rates and do not include the premiums which are required to obtain labor and material in boom times. In depression periods, the indexes do not reflect special price concessions, prompt delivery, improved worker attitude and similar items which tend to reduce costs.

The *Engineering News-Record* publishes at intervals a forecast of expected trends in the ENR index which deserves careful study.

Another forecasting method, based on a probability study of the ENR index since 1918, suggests the assumption of a continued change of index at the same rate as for the previous 6-mo. period within limits of +13% and −7%. This assumption gives a low spread of results as calculated from the mean probable error.

For comparison, a contractor might assume that the index will be unchanged in the succeeding 12 months. Over a long period of time this contractor, who is assuming no change in prices, will be continually bucking-the-odds to the extent of 4 or 5% between bid time and performance on jobs lasting over two years.

Methods such as the above are not perfect, but in making an estimate for a firm bid all possible information must be considered because we cannot avoid forecasting prices.

Errors

Arithmetic errors in estimates are frequent. Errors can and should be avoided by means of an arithmetical check by someone other than the original estimator. A re-estimate by section, using one of the rapid estimating methods, can be used as a general check. It often uncovers gross errors, if they exist.

Imperfections in Estimates

In estimating the cost of a series of process plants, we might have complete drawings, exactly representing the final physical makeup. We might even have a complete forecast of all conditions which will exist during construction. But even under these impossibly favorable conditions, the individual pre-construction cost estimates of the various plants would fall over and short of the actual costs. Flaws, imperfections and approximations inherent in every estimating method are responsible for this variation.

Assuming that completed design information is available and that a careful detailed estimate is made by an experienced estimator, the effect of inaccuracies in method for major projects is probably in the range of ±3%. Small projects, up to $100,000, give more erratic results because there is less chance for averaging out.

When design work is incomplete, preliminary estimating methods must be used. These necessarily have a wider accuracy range than detailed estimates. We made a study of nine completed projects varying in size from $100 thousand to $14 million. We assumed perfect knowledge only of the cost of major process equipment. All other costs such as piping, foundations, buildings, electrical work and instrumentation were estimated by ratios. Results were in the range of ±10% and averaged an underrun of 1%.

However, these results should be accepted with caution because of the small size of the sample, the assumption as to full knowledge of major process equipment cost and the difficulty of maintaining strict mental honesty with respect to hindsight vs. foresight. A range of ±25% is probably more realistic.

Oversights

In making an estimate it is easy to overlook items of construction labor and materials which will be required to perform the work described by the drawings and design reports at hand. Moreover, in the preparation of these drawings and reports, it is equally easy to overlook features which will later be required for the proper functioning of the project. This general tendency is accentuated by any uncertainties in project design at its current stage of development.

Consider Project Uncertainty

Accurate appraisal of the current degree of project development is difficult. A chemical project often begins with reaction computations and proceeds through laboratory tests, pilot-planting, process design, site inspection, engineering design and detailed design. It culminates in actual construction.

Estimates to check the desirability of continuing the project will be required at various stages. Of course, the early estimates will be based on incomplete information and therefore will be less accurate. Later estimates will include omitted items uncovered as development proceeds and will be based on a firmer definition of the required installations.

But where are we in the project development? Often pilot-planting, process design, site inspection, en-

gineering, drafting and sometimes construction are proceeding simultaneously. Knowing that a high degree of project uncertainty means a greater number of probable omissions, how can we rate the uncertainty of the project at the time of estimating?

As an approach to this problem, we have divided project development into:

A. General project basis
B. Process design status
C. Site information
D. Engineering design
E. Detailed design
F. Field performance

The six sections have been expanded into a check list, shown on this page, which is made up of individual items of project development. Each item on the list has been given an arbitrary weight which indicates the degree of uncertainty produced in the over-all project if the item is unknown.

In weighting the items on the list, highest values have been given to items such as process background and raw material quantity because uncertainty with respect to such items can have the most serious effects on project cost. Other items such as sanitary sewer design have been given low ratings since they usually have a relatively minor effect on project cost. While the assignment of weights is grossly arbitrary, they represent the sort of percentage overrun which may be expected if the item in question were completely misjudged.

When information with respect to an item has not yet been established, the full uncertainty rating of the item is entered on the check list. When design or other work with respect to an item on the list is partially complete, its uncertainty rating is proportionately reduced from the maximum value.

If project development is complete and reliable except for the items listed under detailed design and field performance, the uncertainty rating will be 120. If the design of this same project is advanced by completion and checking of the detailed drawings and bills of material, the uncertainty rating is reduced to 50. When the field work is 40% complete (60% incomplete), the uncertainty rating is reduced to 30.

By experience, it has been found that uncertainty with respect to items in the general project basis

Uncertainty Rating Check List

	Maximum Rating	This Project
A. General project basis		
Product and byproducts	100	
Raw materials	100	
Process background	200	
Subtotal A	(400)	
Project basis multiplier (One plus 1% of subtotal A)	5	
B. Process design status		
Flow balances (material, heat, power)	70	
Major equipment, type and size	80	
Materials of construction	30	
Review with research, development and operations	70	
Subtotal B	(250)	
C. Site information		
Surveys, including obstruction and subsoil	45	
Re-usable equipment	25	
Re-usable supports, piping and electrical	25	
Buildings available	30	
Utilities available	25	
Yard improvements available	25	
Climatological information	20	
Local ordinances and regulations	20	
Review with operations	25	
Subtotal C	(240)	
D. Engineering design status		
Layouts	35	
Line diagrams, including utilities	50	
Auxiliary equipment, type and size	45	
Buildings, type and size	35	
Yard improvements, type and size	25	
Hazard control	25	
Coating specifications	10	
Review with research, development and operations	70	
Subtotal D	(295)	
E. Detailed design		
Drawings and bills of material	45	
Drawing checks	25	
Subtotal E	(70)	
F. Field performance	(50)	
Subtotal, Sections B through F	(905)	
Uncertainty rating (Multiply subtotal of sections B through F by project basis multiplier), 905 × 5	(4,525)	
Recommended contingency		
Unlisted Items (Percent of base cost)		
Restricted reserve (Percent of base cost plus unlisted items)		

Establish Detailed Uncertainty Rating for Each Step

		Maximum Rating	This Project*
A. General project basis			
Products and byproducts			
Quantity		50	
Physical form		15	
Chemical composition		15	
Allowable impurities		10	
Wastes		10	
Subtotal		(100)	
Raw materials			
Quantity		50	
Physical form		15	
Chemical composition		15	
Allowable impurities		10	
Source		10	
Subtotal		(100)	
Process background (Suggested values for certain backgrounds are as follows:†)			
Computation only	(150–200)		
Laboratory data only	(110–160)		
Pilot plant data	(60–110)		
Semi-commercial unit data	(20–60)		
Full-scale experience	(0–20)		
Subtotal		(200)	

* Use dash when item is not involved in project. Use zero when item is completely known.
† When necessary divide equipment into groups of similar background and weight on a percentage basis.

B. Process Design Status

	Maximum Rating
Flow balances	
Material	30
Heat	20
Electricity	20
Sub total	(70)
Major equipment, type and size	
Process	50
Storage, raw material	10
Storage, in-process	10
Storage, products	10
Sub total	(80)
Materials of construction	
Records of durability, in identical service	0
in similar service	5
Short-run trials, in identical service	5
Laboratory tests, well-simulated conditions	10
Laboratory tests, preliminary	20
No investigation	30
Sub total	(30)
Review of process design	
With research, development	50
With operations	20
Sub total	(70)

C. Site Information

	Maximum Rating
Surveys	
Obstructions, interferences	20
Property	5
Topographic	5
Subsoil	15
Sub total	(45)
Re-usable equipment	
Type	5
Size	5
Materials of construction	5
Condition	10
Sub total	(25)
Re-usable supports (Piping and electrical)	
Type	5
Size	5
Materials of construction	5
Condition	10
Sub total	(25)
Buildings Available	
Process space	10
Office, control room and laboratory space	3
Toilet, lunch, change rooms	4
Maintenance, stores space	3
Condition	10
Sub total	(30)
Utilities Available	
Power	10
Water	5
Steam and condensate	5
Fuel, air, refrigeration	5
Sub total	(25)
Yard Improvements Available	
Railroads and docks	5
Roads	5
Parking, sidewalks	3
Fencing, planting, light	2
Sewers, storm	5
Sewers, sanitary	2
Sewers, process	3
Sub total	(25)
Climatological Information	
Rainfall, flooding	10
Wind, earthquake	5
Temperature, dust	5
Sub total	(20)
Local Ordinances, Regulations	
Air and water pollution	10
Zoning and building	10
Sub total	(20)
Review with operations	(25)

D. Engineering Design Status

	Maximum Rating
Layouts	
General plant	15
Process, plan	15
Process, elevations	5
Sub total	(35)
Line Diagrams	
Process pipelines, ducts	15
Conveyors, chutes	10
Distribution and supply	
Power	10
Steam, condensate	7
Water	5
Fuel, air, refrigeration	3
Sub total	(50)
Auxiliary Equipment, Type and Size	
Dry and packaged material movement	10
Pumps, compressors, blowers and fans	10
Instruments, controls	10
Power conversion, control	10
Major spares	5
Sub total	(45)
Buildings, Type and Size	
Process	20
Office, control room and laboratory	5
Toilet, lunch, change rooms	5
Maintenance and stores	5
Sub total	(35)
Yard Improvements, Type and Size	
Railroads and docks	5
Roads	5
Parking, sidewalks	3
Fencing, planting, lighting	2
Sewers, storm	5
Sewers, sanitary	2
Sewers, process	3
Sub total	(25)
Hazard Control	
Ventilation, dust, fumes	8
Explosion, fire prevention	7
Air and stream pollution	7
Preliminary insurance review	3
Sub total	(25)

Coating Specifications	
Insulation	5
Painting	5
Sub total	(10)
Review of Engineering Design	
With research, development	20
With operations	50
Sub total	(70)
E. Detailed Design	
	Maximum Rating
Drawings and Bills of Material	
Structural	5
Storage	3
Piping	13
Equipment	4
Instrumentation	2
Insulation (bills only)	2
Electrical	11
Site improvements	5
Sub total	(45)
Drawing Checks	
Safety department	2
Insurance company	3
Operations	20
Sub total	(25)
F. Field Performance	
Sub total	(50)
Reduce from full value to zero in accordance with percent of field labor remaining to complete	

section will produce uncertainties with respect to all subsequent design work. Therefore, the uncertainty rating of this section is used, not as an added item, but in establishing a multiplier for the sum of the ratings of the other five sections.

Considerable judgment is involved in rating the items of the check list, and opinions as to rating individual items will differ. Taking project ratings as a whole, we invariably find agreement within 10% when different estimators rate the same job.

Establish Contingency Allowances

The most dependable guide in establishing proper contingency allowances is past experience. In order to analyze this past experience, actual costs versus estimated costs should be tabulated for all company projects of record. Eliminate from the estimated costs any contingency allowances which may have originally been included. To bring projects of various sizes to a common basis, the data are presented in terms of percentage overruns. Corrections should also be made to compensate for any capacity changes made after the estimate date.

Variations of these overrun percentages are functions of many variables, including among others:

1. Uncertainty status of project at time of estimate
2. General economic condition changes
3. Estimating method used
4. Quantity and quality of cost records available to the estimator
5. Estimator's skill and accuracy
6. Purchasing efficiency
7. Field efficiency
8. Cost efficiency of design if design is completed after the estimate.

When percentage overruns are plotted against uncertainty rating at time of estimate, the pattern shown in the chart on this page develops. While the points have considerable scatter because of the variables previously listed, dominance of the relationship between uncertainty ratings and overruns is apparent.

As additional data become available, it will be possible to classify further the points on the diagram with respect to other variables.

Meanwhile, the overrun pattern of the chart represents an integration of the effect of all of the past practices with respect to estimating, design, purchasing and construction. As such it gives an indication of the contingency allowances which should be applied to future estimates. It also presents a probability picture indicating the probable range of variations between estimated and actual costs as established by a company's historic practice and experience.

Contingency for Unlisted Items

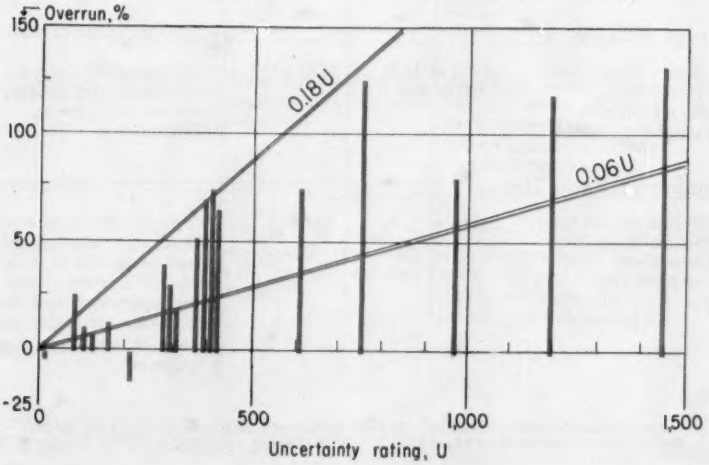
On the chart given here, overruns for only four of the 25 estimates fall below the line marked $U \times 0.06$. In other words, for 84% of the estimates a percentage contingency allowance of at least 0.06 times the uncertainty rating should have been included. Allowing for some improvement in estimating procedures, a percentage contingency allowance called unlisted items in the amount of 0.03 times the uncertainty rating should be included in each estimate. Very seldom will an amount less than this be required.

Restricted Reserve

As a basis for management decision as to whether or not to proceed with a project, it is also desirable to establish the probable maximum overrun which a project may have. This probable maximum can be approximated by the line marked $U \times 0.180$ on the chart. Three points lie above this line so that in 22 out of the 25 cases, or 88% of the time, the overrun percentage has not exceeded 0.180 U. Therefore, the probable cost of a project can be presented as follows:

- Estimated cost includes a percentage contingency allowance for unlisted items of $0.03U$ to take care of normal contingencies. This

Uncertainty Rating Governs Overrun Allowances



amount or more will be required for about 84% of the projects built.

• Restricted reserve is an additional amount some part of which will be needed for about 72% of the projects. For about 12% of the projects, all of this restricted reserve and more will be needed.

In terms of the estimated cost which already includes the allowance for unlisted items and again allowing for improvement in estimating methods, we can compute restricted reserve from the formula:

$$\frac{R}{E} = \frac{(0.10U - 0.03U)}{(100 + 0.03U)}$$

where R is restricted reserve and E is estimated cost.

How to Uses Restricted Reserve

The amount of the restricted reserve necessary at a given stage of project development, when considered along with the income and return estimate, is a guide to management in deciding whether to:

1. Authorize funds for project completion.
2. Drop the project.
3. Authorize additional study, pilot-planting, site investigation or design work before taking final action.

If the project will be a profitable one, even though all of the restricted reserve should be required, management may decide to release it for all-out design, procurement and construction. Thereby, returns are possible at the earliest possible date. If the project cannot make money at the estimated cost, it usually is dropped. Occasionally, further development or design is justified.

In some cases, the project will be a profitable one if it can be built for the estimated cost but unprofitable if all of the restricted reserve should be required. In such cases, further project development is usually authorized so as to more firmly establish the estimated cost and to reduce the amount of the restricted reserve.

When a project does get the goahead, management authorizes only the estimated cost, withholding the restricted reserve. Therefore, the estimated cost is established as a goal to be met by the project team. Restricted reserve funds are released only by approval of supplementary requests supported by detailed justification.

Fit Estimating Method to Needs

Estimating methods require varying degrees of project information for their application. Equipment ratio estimates can be made with a bare minimum of information, while detailed estimates require complete drawings and bills of material. Layout estimates and preliminary bill estimates require less information than detailed estimates but more than equipment ratio estimates. Each of these estimating methods is applicable to a different set of circumstances in project work as shown in the table below.

Equipment Ratio Estimates

When little design information is available and a preliminary estimate of plant cost is required on short notice, the equipment ratio method is recommended. For this estimate, we need to know only:

1. Major process equipment type, size and materials of construction.
2. General extent to which buildings, utilities and yard improvements must be provided.

Accuracy of this information and, therefore, accuracy of the estimate will be affected by the degree

Select Estimating Method Appropriate to Job to Give Best

Information Required [1]	Probable Accuracy [2]	Approximate Cost per $1 million [3]	Process Equipment,[4] Including Instruments
Detailed Unit Cost Method			
General project basis Process design Site information Engineering design Detailed design	±3% at U.R. of 50 or less.	$11,000 to $33,000	Based on firm bids, includes freight, corrected for probable escalation.
Preliminary Bill Method			
General project basis Process design Site information Engineering design Partial detailed design	±6% at U.R. of 100 or less	$3,200	Based on quotes or recent purchase, includes freight, corrected to probable ENR index.
Layout Method			
General project basis Process design Site information Engineering design	±12% at U.R. of 200 or less.	$320	Based on quotes or recent purchase, includes freight, corrected to probable ENR index
Equipment Ratio Method			
General project basis Process design General site information	±25% at U.R. of 400 or less.	$80	Major process equipment based on capacity-cost graphs corrected to probable ENR index. Auxiliary equipment and instruments by ratio to value of major process equipment.

1. See uncertainty rating form (p. 121) for detail of items included in each group.
2. For projects costing more than $100,000. For smaller projects, accuracy ranges will be wide

of uncertainty of knowledge with respect to the following groups of items on the uncertainty rating check list: products and byproducts, raw materials, process background, flow balances, materials of construction background, review of process design, site information and re-usable equipment data.

To organize the estimate, use the equipment ratio estimating form shown on p. 129. Detailed steps in filling out this form are outlined on pp. 127 to 131.

Layout Estimates

When additional site and engineering design information is available, use the equipment ratio method in a modified form to make estimates prior to the completion of drawings and bills of material. A layout estimating form is shown on p. 130.

Since a well-established plant layout is an essential requirement in making an estimate by this method, it is called the layout method. We require the following information for this type:

1. Major process equipment type, size and materials of construction.
2. Auxiliary equipment type, size and materials of construction; including instruments.
3. General layouts and line diagrams.
4. Field inspection of the site.

Accuracy of the estimate will be affected by the degree of uncertainty of knowledge with respect to the groups of items listed for the equipment ratio estimate plus layouts; line diagrams; auxiliary equipment type, size and materials of construction; building type and size and yard improvements.

Layouts should include a layout of the process in plan and in elevation, and a general plant layout including the entire area affected by the project.

For small projects this general plant layout may be identical with the process layout provided no parts of the project are outside the area shown by the drawing. However, it is often desirable to have an inset indicating the general location of the project on the plant site.

Line diagrams should show instrumentation and control. Where applicable, line diagrams should be made for all utility supply and distribution systems and material handling equipment. On these line diagrams should be indicated all

Accuracy With Available Information at Minimum Expense and Time

Installation Material for Process Equipment	Building, Distribution, Yard Material	Labor [5]	Design Expense	Field Expense
Based on completed and priced bills of material, or lump sum bids.	Based on completed and priced bills of material, or lump sum bids.	Based on detailed man-hour estimate and expected labor rates corrected for job conditions, or lump sum bids.	Actual plus estimated design cost of changes.	Detailed budget
Based on preliminary priced bills of material, plus allowances for stores material.	Based on preliminary priced bills of material, plus allowances for stores material.	Based on standard labor-material ratios for detailed work classifications, corrected for job conditions and using expected labor rate for each work classification.	Actual plus estimated design cost to complete.	Preliminary budget.
By ratio to value of process equipment.	From layouts and line diagrams on a unit price basis.	Based on standard labor-material ratios for similar work, corrected for job conditions and using expected average labor rates.	Based on complete drawing list.	Percent of physical plant cost from experience records.
By ratio to value of process equipment.	By ratio to value of process equipment; ratio built to fit expected needs.	Based on standard labor experience ratios for similar work, corrected for job conditions and using expected average effective labor rates.	Man-hr./$ of material cost from experience records at average cost per design man-hour.	Percent of physical plant cost from experience records.

3. For project costing about $1 million. See p. 133 for projects of other sizes.
4. All estimates include an allowance for unlisted items based on project's current uncertainty rating.
5. Standard labor-material ratios are for job condition factor of 1.50 and ENR index of 600.

major items of equipment, with notations of size, type and materials of construction. Materials to be used for pipelines and ducts should also be indicated.

Auxiliary equipment and instruments should be listed in tabular form showing type, size, number and materials of construction.

Buildings should be indicated as to type, size and location on the general plant layout. Abnormal ceiling heights and special needs such as air conditioning should be indicated. Structural materials should be noted such as brick with steel frame or corrugated asbestos on steel frame.

Yard improvements should be indicated as to type and size on the general layout drawing. These include railroads and docks, parking, sidewalks, surfacing and sewers.

Hazard control should be indicated on the process line diagrams. These will include arrangements for ventilation, dust and fume control, explosion and fire prevention and control, and air and stream pollution.

Preliminary Bill Estimates

Preliminary bill estimates can be made when the design of a project has advanced to the point where a preliminary material take-off can be made with reasonable accuracy. The following information is required for this estimate:

1. Major process equipment specifications.
2. Auxiliary equipment and instrument specifications.
3. General layouts and line diagrams.
4. Field inspection of site.
5. Preliminary bills of material coded to standard account subdivisions.

Accuracy of this type will be affected by the degree of uncertainty of all items listed on the uncertainty rating check list.

Detailed Estimates

For a detailed unit cost estimate, all material is priced in detail and all labor is priced on the basis of detailed unit cost records. Part or all of the estimate may be derived from firm bids from vendors and contractors. Accuracy of the estimate will be affected by the degree of uncertainty of all of the items on the uncertainty rating check list.

Follow This List to Prepare Cost Estimates

Step in Estimating Procedure		Equipment Ratio Method	Layout Method	Prelim. Bill Method	Detailed Unit Cost Method
Preliminary examination	(1)	X	X	X	X
Field inspection	(2)		X	X	X
Drawing examination	(3)			X	X
Products	(4)	X	X	X	X
Project divisions	(5)	X	X	X	X
Process	(6)	X	X	X	X
Capacity	(7)	X	X	X	X
Location	(8)	X	X	X	X
Estimate basis	(9)	X	X	X	X
Type of estimate	(10)	X	X	X	X
Project number	(11)	X	X	X	X
Estimating form	(12)			X	X
Uncertainty rating	(13)	X	X	X	X
Material take-off	(14)			X	X
Material pricing	(15)			X	X
Unlisted items	(16)	X	X	X	X
ENR cost index	(17)	X	X	X	X
Job condition factor	(18)	X	X	X	X
Effective pay rate	(19)	X	X	X	X
Site clearing; land costs	(20)	X	X	X	X
Reconditioning	(21)	X	X	X	
Major process equipment	(22)	X	X		
Re-used equipment	(23)	X	X		
Total major process equip.	(24)	X	X		
Auxiliary equipment	(25)	X	X		
Total process equipment	(26)	X	X		
Installation material	(27)	X	X		
Other equipment ratios	(28)	X	X		
Std. labor-material ratios	(29)	X	X	X	X
Job man-hours	(30)	X	X	X	X
Labor take-off	(31)				X
Labor man-hours	(32)	X	X	X	X
Labor cost	(33)	X	X	X	X
Total column	(34)	X	X	X	X
Subtotals	(35)	X	X	X	X
Summary estimate form	(36)			X	X
Division totals	(37)	X	X	X	X
Design expense	(38)	X	X	X	X
Field expense	(39)	X	X	X	X
Estimated cost	(40)	X	X	X	X
Restricted reserve	(41)	X	X	X	
Estimated cost plus restricted reserve	(42)	X	X	X	X
Signature	(43)	X	X	X	X
Copies	(44)	X	X	X	
Review	(45)	X	X	X	
Use of bid pricing	(46)				

Use Applicable Detailed Procedures in Making Actual Cost Estimates

1. Preliminary examination. Examine all available drawings, sketches and reports for the project.

2. Field inspection. Make field inspection of the project site; preferably by the estimator in the company of the project engineer.

For detailed unit cost method where part or all of the work is to be put out for bids, a company representative thoroughly familiar with the project should accompany the contractor or the contractor's estimator during field inspection. It is important that all contractors be given a complete review of the project and site. To prevent later complications, all adverse as well as favorable conditions should be pointed out to each of the contractors during the field inspection.

3. Drawing examination. Available drawings, sketches and equipment lists should be re-examined in detail after the field inspection. Provide bidders with all available drawings required for intelligent bidding including general layouts and subsurface surveys, if part of the work is to be bid.

4. Products. Determine the products, byproducts and any major wastes which are to be produced by the unit. List them on the products line of the summary form.

5. Project division. Study the flowsheet for the process. If the project is a large one and more than one major process is involved, then the estimate should be broken down into process divisions. Use a separate estimate sheet for each division. Assign account subdivision numbers in accordance with the principles given in Part I of this report. (*Chem. Eng.*, Mar. 7, 1960, p. 114).

6. Process. On the process line for each summary should be a brief but inclusive description of the unit process performed by the plant unit. This is especially important because it is quite common to make alternate estimates, assuming different processes but the same products.

7. Capacity. Consult the process flowsheet to determine production capacity of the unit for each of the products, byproducts and major wastes. Enter these values on the capacity line. Capacity values serve to identify the estimate further because more than one estimate may be needed to determine the cost of the plant at several capacities.

8. Location. Give geographical location of proposed plant on summary sheet. For study estimates, it may be necessary to make an arbitrary assumption as to plant location in order to have a reasonable and consistent basis for establishing the various elements of plant cost which are affected by geographical location. For layout estimates, it is preferable that geographical location be established before an estimate is made.

9. Estimate basis. Indicate the general sources of information used by the estimator on the estimate basis line. Include brief notations as to the design information available and notes as to how process equipment was sized, typed and priced. Also give the source of the equipment ratios used in the estimate.

10. Type of estimate. Use suitable code to indicate type of estimate. For example, estimate type numbers are: detailed unit cost method, Type I; preliminary bill method, Type II; layout method, Type III; equipment ratio method, Type IV.

11. Project number. Assign a study number which is the departmental number under which the work on the project is going forward for equipment ratio estimates.

For all other estimates use an appropriation number which is the corporate number assigned to the appropriation request being prepared.

12. Estimating form. A separate detailed estimating form is set up for each sub-account. On each sheet enter the appropriation number and subdivision title and number. List material on form and provide columns for estimating material at unit cost, net cost and gross cost at applicable ENR index. Estimate labor in standard and job man-hours per material dollar at appropriate job condition factor and ENR index and compute labor cost at effective pay rate.

13. Uncertainty rating. With the help of the design engineer, make out and attach to the estimate one of the uncertainty rating forms. This should be done with great care, not only to make sure that the rating is correct but also to use the form as a final check list.

Uncertainty ratings are usually low for detailed unit cost estimates because all drawings for the project must be complete. However, it is entirely possible to have complete detailed drawings on a project where the basic design information is in an incomplete stage. Hence, the uncertainty rating would be correspondingly high.

14. Material take-off. For each drawing, material quantities should be taken off and these quantities and their units entered on preliminary bill estimate sheets opposite the appropriate account subdivision numbers. Since the drawings at this stage of a project are usually incomplete, some of these quantities must necessarily be approximated. For example: piping may not be completely detailed. However, it may be possible to list the approximate lineal feet of pipe of various sizes and to list valves and major fittings.

For detailed estimates, bills of material are usually available from the design group.

15. Material pricing. For preliminary bill estimates, obtain unit prices from the sources given in Part I (*Chem. Eng.*, Mar. 7, 1960, p. 117). Bills of material are usually available for the detailed unit cost method. Bills are priced and the value of material is entered in the net material cost column. For both methods, show the ENR cost index at which the material is priced at the top of the column.

Net material cost is the product of the quantity and the unit cost of each item. Gross cost of material for an account subdivision is the cost at the probable ENR index of the project including the unlisted items allowance. It is obtained by applying the unlisted items percentage to the net cost.

16. Unlisted items. The unlisted items percentage is determined by multiplying the uncertainty rating of the project by 0.03. This percentage is added to the estimated cost of each of the pieces of process equipment and to all other material items. It is an allowance for the bare minimum of cost items which will inevitably be overlooked in an estimate.

17. ENR cost index. Use the value of the ENR construction cost index that is assumed to be applicable to the period during which the project is under construction. Usually the 12-month forecast of the estimating department can be used for this purpose; or the estimate can be based on a no-price-change assumption and is presented with this qualification.

18. Job condition factor. Determine the job condition factor by filling out a check list of job conditions as described in Part I (*Chem. Eng.*, Mar. 7, 1960, p. 121). This factor has a very powerful effect on the final estimate amount. However, if time is pressing and assuming that a good contractor will perform the work on a new site under ordinary construction conditions, use a job condition factor of 1.20. Contract work in an operating plant calls for a factor of about 1.50. Spare-time construction by maintenance groups may rate about 2.10. In case of doubt, complete job condition factor sheet and attach to project file copy of estimate. In some cases, job conditions may vary enough between divisions to require separate job condition factors.

19. Effective pay rate. Determine effective pay rates as outlined in Part I of this report. (*Chem. Eng.* Mar. 7, 1960, p. 126).

20. Site clearing and land. Site clearing and land costs can be estimated according to the principles

Applicable Procedures

given in Part I (*Chem Eng.*, Mar. 7, 1960, p. 117). Field inspection of the site is very desirable and an investigation of local land prices may be required. For detailed unit cost estimates, separate subaccounts are established, as required, for these items and a detailed estimate of their cost made.

21. Reconditioning. Equipment to be re-used for the project must be given a field inspection to determine its cost of reconditioning. The necessary work should also be discussed with the design engineer. Materials and man-hours are approximated and the effective pay rate and unlisted items percentage applied to get the total reconditioning cost.

22. Major process equipment. List type, size and number of each of the items of major process equipment. Price the equipment, add the unlisted items percentage and enter the dollar values in the material column. The great influence of major process equipment prices on the estimate total justifies the pricing of the expensive and doubtful items by means of preliminary quotations from vendors.

23. Re-used equipment. The new value of re-used equipment must be considered in using equipment ratios. Any equipment which is to be re-used for the project should be priced at its present market value new; and this value entered in the brackets in the material column. The unlisted items allowance computed on the cost new basis should be entered just below in the material column as shown in the estimate form on p. 129.

24. Total major process equipment. Sum of new major process equipment as listed in the material column plus the new value of re-used equipment. There are no entries in the other columns on this line.

25. Auxiliary equipment. For equipment ratio estimates, use the auxiliary equipment ratio from records of past jobs. The ratio selected as appropriate for the process division is entered in the space marked e_a. The product of e_a and total major process equipment value E_m gives the estimated value of auxiliary equipment for the project.

For layout estimates, list and price auxiliary process equipment, including instruments and motor control equipment, in the same manner as major process equipment. Use a separate sheet and attach to project file copy of the estimate summary. Only the more expensive pieces of auxiliary equipment need be priced by preliminary quotations from vendors. Enter total value of auxiliary process equipment including allowance for unlisted items on the estimate summary form shown on p. 130.

26. Total process equipment. Total process equipment value is the sum of major process equipment value and auxiliary process equipment purchased new plus the new value of re-used equipment. The unlisted items allowance is also included.

27. Installation material. Select the installation material ratio m_i from records of past projects. This ratio is defined and developed in Part I (*Chem. Eng.*, Mar. 7, 1960, p. 120). The product of installation material ratio m_i and total process equipment E_p gives the value of installation material for the project.

28. Other equipment ratios. Ratios for piping material, wiring material, building material and distribution and yard material are selected and applied in accordance with Part I (*Chem. Eng.*, Mar. 7, 1960, p. 120).

For layout estimates, building material and distribution and yard facilities are estimated as follows:

Area, height and construction materials for the process buildings are determined from the layout drawings. The buildings are priced on the basis of costs per unit area or per unit volume plus the unlisted items allowance. Service buildings are priced in a similar manner. Buildings serving more than one process division are listed and estimated in a separate division which also includes distribution and yard facilities.

Essential physical dimensions and distribution facilities such as pipelines for products, steam, water or gas service, sewers and power facilities can be obtained from the layout drawings. Use unit cost data as discussed in Part I to price these facilities and add unlisted items allowance.

29. Standard labor-material ratios. Standard man-hours per material dollar are selected for each material or equipment item from past jobs of record. The heading of the estimate sheet should indicate the projects of record used as the source of these ratios. See Part I for a discussion on the use of standard labor-material ratios.

For detailed unit cost estimates, standard unit man-hours are obtained from the sources indicated in Part I. However, it is sometimes difficult to locate unit labor cost records for a particular type of work.

30. Job man-hours. It is necessary to convert standard labor-material ratios to the conditions of a particular job. This is done by multiplying the standard man-hours per material dollar by the ratio of the job condition factor for the project to the standard job condition factor of 1.50; then multiplying by the ratio of the standard ENR cost index of 600 to the assumed ENR cost index for the project. If more than one job condition factor is required, a separate computation is made for each.

31. Labor take-off. List each item of work required for the project subdivision in the description column. Indicate drawing number which best shows the work to be done on estimate form.

32. Labor man-hours. Labor man-hours are the product of material dollars and job man-hours per material dollar. For used equipment which is to be re-installed, use value based on market value new rather than book value.

33. Labor cost. Labor cost is the product of labor man-hours and the effective pay rate. Labor dollars are rounded so as to avoid an unrealistic number of significant figures in the totals columns of the estimate.

34. Total column. The figures in the total column are the total of material and labor dollars for each item.

35. Subtotals. Columns should be subtotaled and the subtotals cross-checked where possible. If the project has more than one division, subtotals are carried over to the final sheet.

36. Summary estimate form. As a summary of the project estimate, prepare estimate summary sheets. Reference should be made to the detailed sheets for cases of variation in uncertainty rating, ENR cost index, job condition factor, effect pay rate and unlisted items allowance.

37. Division totals. A separate estimate summary sheet is used for each division, and the subtotals from these sheets carried over to a final division summary sheet. On this sheet are listed the divisions of the project with total estimated material, man-hours, and labor cost for each.

38. Design expense. For equipment ratio estimates, standard design man-hours per material dollar are obtained from the graph in Part I (*Chem. Eng.*, Mar. 7, 1960, p. 128). Standard values are adjusted to the job conditions by noting whether the engineering fits an easy, difficult or standard classification. Probable value for the job is entered in the estimate. Multiplying job design man-hours per material dollar by the value of project material at ENR 600 gives design man-hours for project.

A complete drawing list is often available for layout estimates. With the assistance of the project engineer the probable man-hours per drawing can be estimated so as to determine the man-hours required for the project. Unlisted items percentage is added to this figure. As a check, the job design man-hours per material dollar at ENR 600 should be computed and compared with the standard design man-hours per material dollar obtained from the graph in Part I. Effective cost of a design man-hour for both estimates is determined from current department records.

For preliminary bill and detailed unit cost estimates, most of the engineering has already been completed.

(*Continued on page* 131)

Prepared Estimating Form Saves Time for Equipment Ratio Estimates

EQUIPMENT RATIO ESTIMATE

PRODUCTS: ORTHOSILICATE & METASILICATE	LOCATION: CINCINNATI	DATE: 6-27-56	STUDY NO.: OF-00-1
PROCESS: CONTINUOUS		EST. NUMBER, THIS APPROP.: 1	
CAPACITY: INCREASE OF 1,500 # FLAKED PRODUCT PER HOUR		ESTIMATE TYPE: IV	
		UNCERTAINTY RATING: 330	
		UNLISTED ITEMS: 10 %	
ESTIMATE BASIS: RATIOS FROM JOB NUMBER F-6706 MAJOR PROCESS EQUIPMENT DATA BY N.A.		ENR. COST INDEX: 640	
		JOB CONDITION FACTOR: 1.20	
		600/640 x 1.20 /1.50 = 0.75	
		EFF. PAY RATE: $3.00	

DESCRIPTION & QUANTITY	MATERIAL	M.H./$M STD.	M.H./$M JOB	LABOR MAN-HRS.	LABOR DOLLARS	TOTAL
SITE CLEARING, RECONDITIONING, AND LAND	1,400	—	—	1,125	3,300	4,780
MAJOR PROCESS EQUIP., INCL. UNLISTED ITEMS						
Caustic Storage Tank & Coil (Ni-clad 15' D. x 20')	14,200	0.137	0.103	1,462	4,350	18,550
Dry Material Storage	500	0.100	0.075	38	110	610
Evaporator (Ni tubes & Ni-clad)	5,800	0.026	0.020	116	350	6,160
Separator	900	0.026	0.020	18	50	950
Ortho Mixer	900	0.083	0.062	56	170	1,070
NEW VALUE OF RE-USED EQUIP.	(200)	0.026	0.020	12	40	240
UNLISTED ITEMS FOR RE-USED EQUIP.	—	—	—	—	—	—
TOTAL MAJOR PROCESS EQUIP. Σ_m 22,900	XXXX	XX	XX	XXX	XXXX	XXXX
AUXILIARY EQUIPMENT, INCL. UNLISTED ITEMS e_a 0.358	8,200	0.091	0.068	557	1,670	9,870
TOTAL PROCESS EQUIPMENT Σ_p 31,100	XXXX	XX	XX	XXX	XXXX	XXXX
INSTALLATION MATERIAL m_i 0.138	4,300	0.280	0.210	904	2,710	7,010
PIPING MATERIAL m_p 0.190	5,900	0.225	0.169	997	2,990	8,890
WIRING MATERIAL m_w 0.048	1,500	0.283	0.212	318	960	2,460
BUILDING MATERIAL m_b 0.068	2,100	0.214	0.161	338	1,020	3,120
DISTRIBUTION & YARD MATERIAL m_y —	—	—	—	—	—	—
COPIES TO: R.V.N. SUB TOTAL, NEW MATERIAL	$ 45,700	AV.	AV.		$	$
SUB TOTAL, INCL. RE-USED MATERIAL	(45,900)	0.17	0.13	5,940	17,800	63,700
DESIGN EXPENSE @ 5.50 $/M.H.	(43,000) @ ENR. 600	0.060	0.066	(2,840)	15,600	$ 15,600
FIELD EXPENSE 25 % OF SUB TOTAL.	6,400	0.67	0.50	3,170	9,500	$ 15,900
TOTAL ESTIMATED COST	$ 52,300	XXX	XXX	FIELD 9,110	$ 42,900	$ 95,200
RESTRICTED RESERVE 21 %						$ 20,000
TOTAL ESTIMATED COST PLUS RESTRICTED RESERVE						$ 115,200

CONST. FILE	ESTIMATOR	DATA CHECK	ARITH. CHECK	APPROVED	EST. TIME-M.H.
X	J.P.S.	H.W.	P.C.H.	E.F.G.	2

Use Summary Form to Consolidate Cost Data for Other Estimates

ESTIMATE SUMMARY

PRODUCTS: TREATED BRINE	LOCATION: PITTSBURGH	DATE: 2-10-56	APPROPRIATION NO.: ZF 00 331
PROCESS: DOUBLE CIRCULATION		EST. NUMBER, THIS APPROP.: 2	
CAPACITY: 200 T/DAY, SOLID BASIS		ESTIMATE TYPE: III	
		UNCERTAINTY RATING: 366	
		UNLISTED ITEMS: 11 %	
ESTIMATE BASIS: MAJOR PROCESS EQUIPMENT FROM QUOTES. RATIOS FROM ZF-0671 AND G-1112. LAYOUT DRAWING NO. 160-D: FLOW DIAGRAM NO. 159-C.		ENR COST INDEX: 650	
		JOB CONDITION FACTOR: 1.35	
		600/ 650 x 1.35 /1.50= 0.83	
		EFFECTIVE PAY RATE: $3.20	

APPROP. SUB-ACCT. NO.	DESCRIPTION & QUANTITY	MATERIAL	MH/$M STD.	MH/$M JOB	LABOR MAN-HRS.	LABOR DOLLARS	TOTAL
	Site Clearing						
	Remove Brick Building	---	---	---	200	660	660
	Relocate 500' of 2" Water Line	200	---	---	350	1,100	1,300
	Major Process Equipment						
	Heat Exchangers, 6	76,300	0.020	0.017	1,300	4,160	80,460
	Treat Tanks, 4	21,200	0.120	0.100	2,120	6,780	27,980
	Auxiliary Process Equipment						
	Pumps, 12	9,000	0.070	0.058	522	1,670	10,670
	Controllers, 2	3,100	0.083	0.069	214	690	3,790
	pH Recorder	2,500	0.035	0.029	73	230	2,730
	Power Control Center	5,300	0.160	0.133	705	2,260	7,560
	Total Process Equipment, Ep = $117,400	---	---	---	---	---	---
	Installation Material, Ep x 0.138	16,200	0.280	0.232	3,760	12,040	28,240
	Piping Material, Ep x 0.190	22,300	0.230	0.191	4,260	13,620	35,920
	Wiring Material, Ep x 0.048	5,600	0.300	0.249	1,395	4,460	10,060
	Control House, 20' x 10' @ $4M/sq. ft.	800	0.345	0.286	229	730	1,530
	Access Road, 1400'	4,200	0.754	0.625	2,630	8,400	12,600
	COPIES TO: J.A.B. — SUBTOTAL	$ 166,700	AV.	AV.	17,760	$ 56,800	$ 223,500
	F.H.Q. — DESIGN EXPENSE @ 5.50 $/MH	(154,000) DIR 600	0.048	0.050	(7,700)	42,300	$ 42,300
	FIELD EXPENSE 23 % OF SUBTOTAL SPLIT % MAT. % LABOR	20,500	XXX	XXX	9,650	30,900	$ 51,400
	TOTAL ESTIMATED COST	$ 187,200	XXX	XXX	FIELD 27,410	$ 130,000	$ 317,200
	RESTRICTED RESERVE 21 %						$ 66,800
	TOTAL ESTIMATED COST PLUS RESTRICTED RESERVE						$ 384,000
	CONSTRUCTION FILE: G.V.B. — ESTIMATOR: J.A.W.	CHECKED: E. F. G.			APPROVED: W. J. H.		EST. TIME, M.H.: 18

Applicable Procedures

Hence, a major part of the design expense is determined from department records. An allowance for changes and additions to drawings is established by multiplying the unlisted items percentage by the total of the actual design cost to date.

39. Field expense. For small projects, field expense is usually included in the effective pay rate. For the larger projects, it can be approximated from the percentage graph in Part I (*Chem. Eng.*, Mar. 7, 1960, p. 129); For intermediate projects the field expense can be included in the effective pay rate, with special consideration for particular items such as a resident field engineer.

For preliminary bill estimates, field expense is computed on the basis of a preliminary construction expense budget. This can be done on a separate detailed estimate sheet and the total only carried over to the estimate summary sheet.

For detailed unit cost estimates, account subdivisions for field expense are established and the costs connected with each computed on a separate detailed estimate sheet. Totals for these subdivisions are individually listed on the estimate summary sheet and the grand total entered on the final sheet.

40. Estimated cost. This is the total of field expense, design expense and the subtotals of the individual account divisions.

41. Restricted reserve. Restricted reserve is established from the formula

$$\frac{R}{E} = \frac{0.07U}{100 + 0.03U}$$

where R is restricted reserve, E is estimated cost and U is uncertainty rating. The resulting percentage is entered in the space indicated and applied to the estimated cost to determine the amount of the restricted reserve. Values of the constants in the equation may be varied to produce the desired relationship between overruns and underruns.

42. Estimated cost and restricted reserve. This is the probable maximum cost of the project and is entered in the total column.

43. Signature and checking. The estimator should note his initials on the line indicated and turn the estimate over to another member of the department for checking of arithmetic. The estimate then goes to the senior estimator for general checking. Both the arithmetic checker and senior estimator initial the estimate. When checking work is completed, the total man-hours required to prepare and check the estimate are noted.

44. Copies. Copies of the estimate can be prepared by suitable duplicating methods. Copies are distributed to the individual requesting the estimate, to the estimating section's file, to the chief project engineer and any other interested engineering personnel. The detailed estimate sheets are kept in the estimating section's project file. If necessary, duplicates of these sheets can be made for the use of the design engineer and others.

45. Review. Estimates of major importance may be reviewed by a committee made up of:

Staff engineer who made original study
Design engineer for project
Field construction engineer
Estimator

46. Bid prices. If parts of the project have been bid by outside contractors, bid prices are used instead of estimated prices to make up the estimate summary. Source of bids should be indicated.

It is particularly important in contracting part or all of the work to make sure that there are no overlapping contracts, and no gaps between contracts which must be filled by plant labor or other contractors.

Re-Estimates Improve Accuracy and Control Final Cost

Re-estimates are made during the construction of a project to improve the accuracy of the estimate of final cost. They should be made in such a way so as to take advantage of all actual cost information which has become available up to the time of the re-estimate.

A re-estimate form as shown on p. 132 can be used to make labor or material re-estimates. Both forms could be combined but separate forms are used for labor and material re-estimates so as to get concurrent help from the field engineer and the design engineer.

Material Re-Estimates

On re-estimate form for materials show number, title and appropriation estimate for each subaccount of the project. For convenience, each subdivision should be listed on a separate sheet or group of sheets. Design commitment to date totals are obtained from the appropriation ledger and entered in the columns shown.

With the help of the project engineer and the field supervisor, the estimator can approximate the amount of material yet to be requisitioned for each subdivision. This is entered in the required-to-complete column. For some subdivisions, there may as yet be no design commitment. In such cases, the full appropriated amount will presumably be needed to buy material for the subdivision.

The sum of design-commitment to date and the required-to-complete is the revised estimate for each subdivision.

A new uncertainty rating should be made. Separate ratings should be made, if necessary, for the various project divisions. An unlisted items percentage is determined by multiplying the uncertainty rating by 0.03. It is entered in the blank space provided at the bottom of the revised material estimate sheet.

The unlisted items allowance is determined by multiplying the revised material estimate total for the division by the unlisted items percentage. Allowance for unlisted items should be added even though it gets down to a very small percentage. The unlisted items percentage applies to the entire material estimate, but the resulting dollar values should be distributed to open accounts only.

In the latter stages of the project, the appropriation ledger should be checked against the construction ledger which is maintained in the field by the project accountant. This check usually uncovers additional charges such as freight and escalation which must be included in the re-estimate. On occasion, invoiced amounts will be greater or less than the order amounts.

After completion of the material re-estimate, a field inspection should be made to check this re-estimate and to obtain information with respect to labor progress.

Labor Re-Estimates

Number, title and appropriation estimate amount for each account subdivision should be entered on a re-estimate form similar to the one shown on p. 132. Separate sheets or groups of sheets should be used for each of the project's divisions. If more convenient, the form can be made out in terms of man-hours rather than dollars.

Labor expenditures to date are

Use Prepared Forms to Make Labor or Material Re-Estimates for Each Subaccount

LABOR PROGRESS REPORT AND RE-ESTIMATE, As of _____

Title _____ No. _____

Reported by _____ Sheet No. _____

Account Number	Account Title	Appr'n. Estimate	Expended to Date	% Complete	Req'd. to Complete	Revised Estimate

obtained from the field accounting group and entered in the column as shown. Percent labor completion of each subdivision is estimated by the field engineer or by the estimator after a detailed field inspection. It is important that these completion figures be based on conditions as they existed at the closing date of the expended-to-date amounts.

In some cases, especially when work on a subdivision is approaching completion, it is easier and more accurate to estimate man-hours and dollars required to complete the work rather than estimating the percent completion.

It is necessary to check the current revised material estimate when estimating percent completion or required to complete. Proposed additions or changes are often known to the design engineer and included in the material re-estimate well in advance of revision and issue of drawings to the field engineer.

Revised labor estimate is either the sum of the expended-to-date and the required-to-complete figures or the expended-to-date figure divided by percent complete. Whichever method seems likely to produce the more accurate result should be used. If work for a subdivision is contracted on a lump-sum basis, the bid amount plus change orders to date plus estimated work by others is totaled to get the revised labor estimate.

Unlisted items are computed for each division in the same manner as for material. In connection with the monthly analysis report, the unlisted items allowance can be distributed to appropriation divisions in proportion to the required-to-complete dollars.

Labor re-estimate forms are also useful in construction-labor control. If the field supervisor finds that the re-estimated cost of a subdivision departs substantially from the appropriation estimate, he should take immediate steps to find out why and initiate any action necessary.

As a summary of the project re-estimate, estimate summary sheets of the form shown on p. 130 should be prepared. The type of estimate will be marked Re-. Appropriation number, current uncertainty rating, current ENR index and the unlisted items allowance should be entered. Job condition factor and effective pay rate are re-estimated if necessary.

Division totals only from the detailed estimate sheets are transferred to the estimate summary. Each division entry includes the title of the division, the gross cost of material, labor dollars or man-hours and total re-estimated cost for the division.

Design expense is the recorded cost of design to date plus the current unlisted items percentage to take into account changes which will be required during completion of the project.

Field expense is re-estimated on a detailed subaccount basis in a manner similar to that used for other divisions.

Required Estimating Time

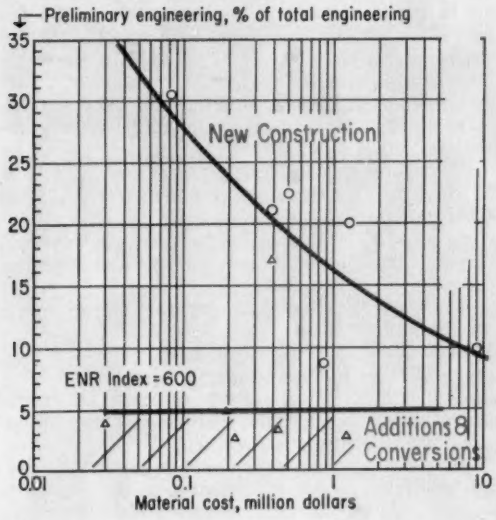
In scheduling estimating work and in appraising and selecting estimating methods, it is desirable to have a means of predicting estimating time and money which will be required to make an estimate by a given method for a project of a certain size.

On the next page is a graph of estimated total project cost versus estimator man-hours for some 90 projects. Estimates were made by three different methods as shown. Man-hours include checking-time but not stenographic time.

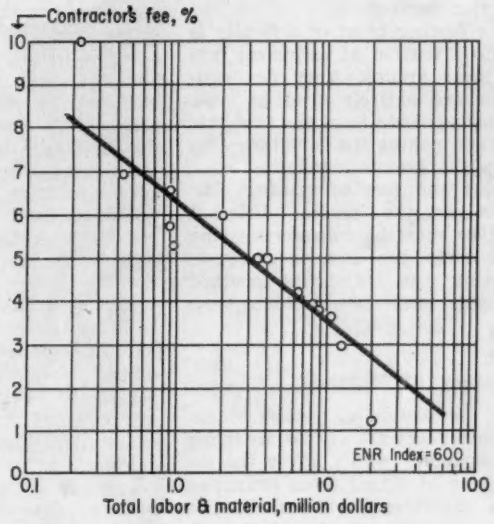
The points of the graph show considerable scatter. Part of this is due to the fact that eight estimators with varying degrees of experience were at one time or another employed on the work. There was also a considerable variation in the degree of development of the basic project information supplied to the estimators. In some cases part or all of the equipment and material pricing was done by design or staff engineers whose time was not recorded with the estimating time.

Some of the scatter, especially for jobs involving only a few man-hours, is due to the difficulty of determining just exactly how many hours should be assigned to a particular job. This is particularly true since all of the individuals concerned had concurrent assignments

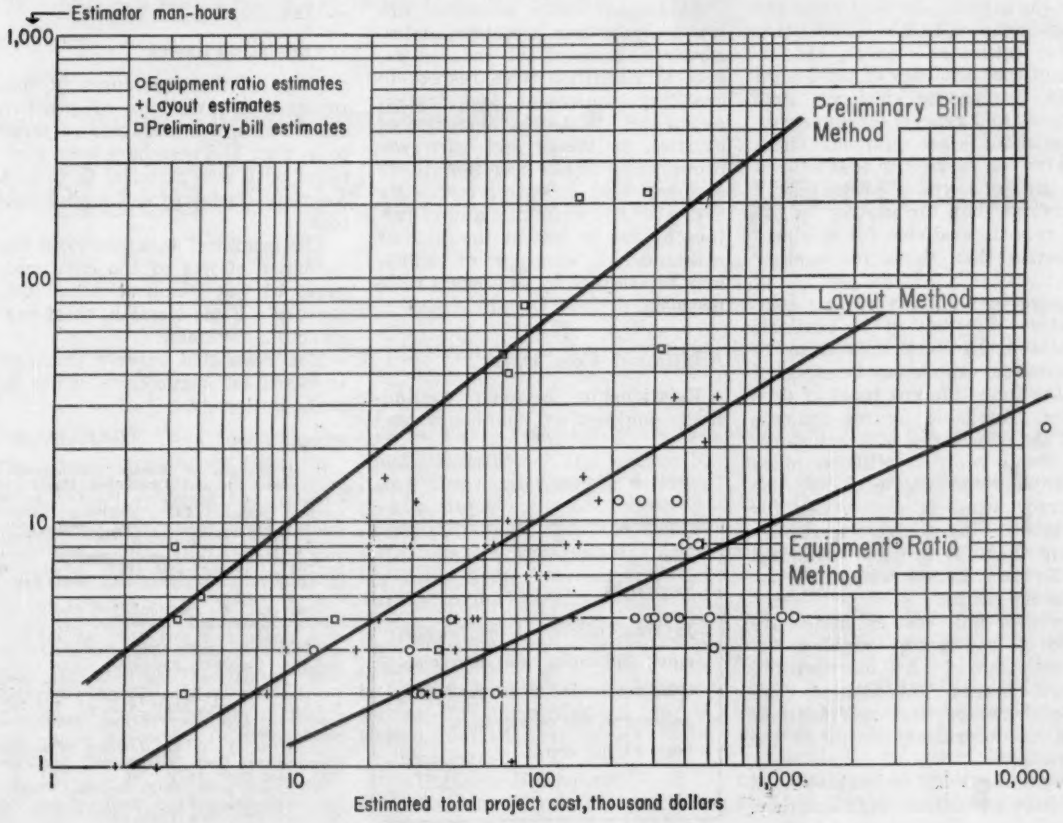
Find Total Engineering Man-Hours



Compare Fees to Project Costs



Estimating Time Depends on Project Cost and Estimating Method



in cost analysis work and field construction service.

One further point of difficulty is the classification of estimates into the three groups. Very few estimates are entirely true to type. Estimates shade from one type into the next making the boundaries between the groups indefinite.

Time and cost of making estimates by the several different methods must be considered along with their probable accuracy in selecting the estimating method currently most suitable for a project.

Accuracy of Methods

In the section on establishment of contingency allowances, we listed the variables which affect the divergence of actual from estimated costs. Since estimating method is only one of the list of variables affecting the accuracy of an estimate, it is very difficult to segregate its effects.

Quite often, successive cost estimates are made by different methods by the same estimator for a single project. In this case, the cost is common to the several successive estimates. Hence, the effects of cost efficiency of the design group, purchasing efficiency, field efficiency and general economic condition changes are nullified. There remains the possibility that skill in executing one type of estimate may be greater than for another, or the cost records available for one may be better than those for another type.

As yet not enough of this comparative information is available to establish reliable figures as to the accuracy which may be expected for the four different types of estimates. Available figures indicate that the percentage accuracy range for small projects will be much wider than for large projects. The accuracy band is also wider for projects having a high uncertainty rating than for projects estimated by the same method with a low uncertainty rating.

Detailed unit cost estimates are made by contractors with an accuracy range of ±3% disregarding design changes. This assumes complete drawings and specifications with an uncertainty rating in the 50 range.

Preliminary bill estimates should also have a relatively high accuracy. The material portion of an estimate made by this method is firmly established. Labor which is computed by labor-ratios, however, cannot be as accurate as a good unit man-hour estimate. Although complete information is not available, it is believed that preliminary bill estimates can be made with an accuracy of ±6% provided the project is in the over $100,000 range and the uncertainty rating at the time of the estimate is less than 100.

Layout estimates have a wider accuracy range than preliminary bill estimates since much less information is used. Accuracy of the equipment portion of layout estimates should be good because all of these items are listed and priced. Installation material and labor which are based on ratios will have a lower degree of accuracy. Although no actual information is available, it has been tentatively assumed that for projects costing more than about $100,000, with uncertainty ratings at the time of estimate of 200 or less, an accuracy of ±12% can be obtained.

Equipment ratio estimates are less accurate than layout estimates, mostly because of the reduced degree of definition with respect to auxiliary equipment and instruments and the sketchy definition of utilities, buildings and yard improvements. It has been tentatively assumed that for projects costing over $100,000 with uncertainty ratings of 400 or less at the time of estimate, an accuracy of ±25% may be attained by equipment ratio methods.

Additional Cost Data

Relationship between preliminary engineering manhours and total engineering man-hours is shown in the graph on p. 133 for process projects. This information is sometimes valuable in the early stages of project planning. Preliminary engineering for process projects is arbitrarily defined as including:

Mechanical flowsheets

General arrangement drawings and block models

Preliminary equipment, drawing, account subdivision and material lists

Specifications for major equipment

Site information

Preliminary project schedule

Preliminary estimate of capital cost, manufacturing costs and income and return.

Another chart on p. 133 provides some information with respect to construction fees which have been charged in the past by contractors on major projects. The contractor's fee in this case includes his home office overhead and profit but does not include any of the other items of field expense previously listed in Part I (*Chem. Eng.*, Mar. 7, 1960, pp. 129-130).

ACKNOWLEDGEMENTS

Many of the procedures in this report are variations of practice described in the literature referred to in Part I. These have been combined with new material to form a complete, inclusive estimating system.

The graphical data represent the combined efforts of the cost engineers of the Diamond Alkali Co., especially Blase Nemeth, chief construction engineer.

The restricted reserve principle is based on suggestions made by C. A. Butler, Jr.

REFERENCES

U. S. Bureau of Mines, "Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants," Information Circular 7516, 1930-Sept. 1948; Information Circular 7705, Sept. 1948-June 1952; Information Circular 7751, July 1952-June 1954; Information Circular 7847, July 1954-Dec. 1956; Information Circular 7916, Jan. 1957-Dec. 1958. Series is continuing.

Weaver, J. B., "Annual Cost and Profitability Estimation Review," for 1926-1953, *Chem. Eng.*, Oct. 1954, pp. 185-193; for 1948-1954, *Chem. Eng.*, June 1955, pp. 247-252; for 1955, *Ind. Eng. Chem.*, May 1956, pp. 934-942; for 1956, *Ind. Eng. Chem.*, June 1957, pp. 936-946; for 1957, *Ind. Eng. Chem.*, May 1958, pp. 753-762; for 1958, *Ind. Eng. Chem.*, May 1959, pp. 689-696.

Aries, R. S., R. D. Newton, "Chemical Engineering Cost Estimation," McGraw-Hill, New York, 1955.

Vilbrandt, F. C., C. E. Dryden, "Chemical Engineering Plant Design," 4th Ed., McGraw-Hill, New York, 1959.

ULTRASONIC FLAW DETECTION and inspection check quality of weld at each welding mill on a continuous basis.

Savings*

Welded vs. Seamless Tubes

O.D. Inches	B. W. Gage	Savings, %
Average Wall Tubes		
¾	14	11.1
¾	16	31.4
¾	18	24.1
⅞	14	10.8
⅞	16	31.2
⅞	18	18.4
1	12	17.7
1	13	17.0
1	14	21.7
1	16	32.2
1	18	15.7
1¼	13	26.0
Minimum Wall Tubes		
¾	14	11.2
¾	16	29.9
¾	18	24.2
⅞	14	10.8
⅞	16	29.6
⅞	18	18.4
1	12	15.8
1	13	15.1
1	14	19.9
1	16	30.6
1	18	15.7
1¼	13	24.3

* LECTROSONIC brand welded heat exchanger tubes cost less than seamless tubing by the percent indicated, based on published prices in effect June 1, 1959. Calculations based on mill point value/100 ft.; cut length 10-24 ft.; in price bracket 40,000 lb. or ft.

Design Engineers Are Rediscovering That . . .

Welded Tubes Slash Equipment Cost

New methods of manufacture and control are combating the prejudice that had been built up against the welded tube.

E. W. ALLARDT, Chief Engineer, Keystone St. Plant, Tubular Products Div., Babcock & Wilcox Co., Alliance, Ohio.

ELECTRIC - RESISTANCE - WELDED pressure tubing has been available since the middle 1930's for the fabrication of process equipment. It was then that the ASME Boiler Code Committee first authorized its use.

And there's no question that welded tubes are in many cases much less expensive than their seamless counterparts. Price comparisons are given in the display table above and in *CE* Cost File on p. 156 of this issue.

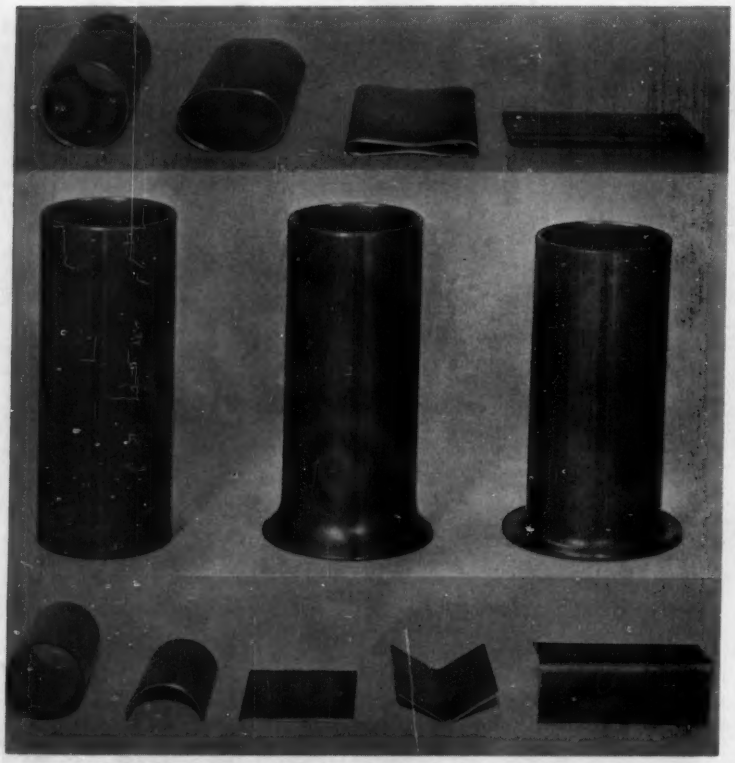
Why then do design engineers still shy away from specifying an equally satisfactory and less costly item? The answer can be summed up in a single word: prejudice.

The purpose of this article is to dispel this prejudice with engineering fact. Today, new methods of manufacturing electric-resistance-welded pressure tubing (carbon steel, not alloys) and advanced techniques in process and quality control—as well as realistic application testing—are contributing to a welded product that boasts these qualifications:

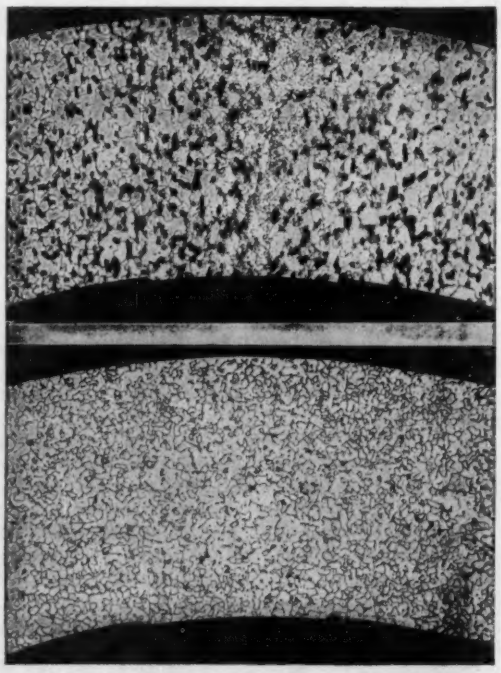
- Uniform dimensions.
- Uniform physical properties.
- Easily workable.
- Meets strength specifications.
- Costs less.

Today there are at least five large suppliers of welded tubing who can claim these same honors. In reverse alphabetical order they are: Standard Tube Co., Detroit; Republic Steel Corp., Cleveland; National Tube Div. of U. S. Steel, Gary; Jones & Laughlin, Oil City, Pa.; and the Tubular Products Div. of Babcock & Wilcox in Alliance.

Admittedly, as one of the major manufacturers of welded tubes, we at B&W might be accused of har-



DEFORMATION TESTS include flattening, flanging and expanding.



STRONG WELD is indicated by the homogeneous grain structure in lower photomicrograph.

boring our own prejudice—directed in favor of welded tubes. However, since we are one of the largest manufacturers of both seamless and welded tubing, we are not really perched on one side of the question or the other. We are more concerned with getting the engineering facts straight.

For if American manufacturers are to meet the ever-increasing challenge of foreign competition, the price advantage of West German and Japanese steels can only be overcome by more extensive use of the lower-cost welded products that are fabricated in this country.

Well-Deserved Black Eye

Manufacturers of welded tubing will be among the first to admit that there has been some justification for the prejudice that has been built up against the use of welded tubes for high-pressure applications. During World War II, welded tubing got a black eye. Here's why.

In the early 1940's a large percentage of tubing used for marine boilers was manufactured by electric-resistance welding. When America entered the war, an acute shortage of heat exchanger and condenser tubes developed. Refineries were expanding at a rapid pace for the manufacture of aviation gasoline, competing with the demands of the Navy and Merchant Marine for pressure tubing.

In this emergency, manufacturing specifications and codes were relaxed. Some producers of mechanical tubing (that used in the manufacture of kitchen furniture, for example), were called upon to manufacture pressure tubing for which they did not have the proper experience and equipment.

Tubing produced under these conditions and in this way was sometimes unsatisfactory for the job it was expected to do. Therefore, manufacturers of electric-resistance-welded pressure tubing suffered a considerable loss of prestige.

The prejudice that was built up against the use of welded tubes for heat exchangers has been gradually disappearing within the last ten years or so. As more and more quality welded tubing is placed in service and proves itself, the market grows larger. Today, more and more engineers are saving on initial

These Hydrostatic Test Pressures (psi.) Are Used For Tubes

To ASTM A-214, Minimum and Average Walls

Tube Size, In.	0.030	0.035	0.042	0.049	0.058	0.065	0.072	0.083	0.095	0.109	0.120	0.135	0.148	0.165	0.180
1/2	2,600	3,100	3,800	4,500	5,300	6,000									
5/8	2,100	2,400	3,000	3,500	4,200	4,700	5,300	6,000	6,000						
3/4	1,700	2,000	2,400	2,900	3,500	3,900	4,400	5,100	5,800	6,000					
7/8	1,400	1,700	2,100	2,400	2,900	3,300	3,700	4,300	5,000	5,700					
1	1,200	1,400	1,800	2,100	2,500	2,900	3,200	3,700	4,300	5,000	5,500	6,000	6,000		
1.050	1,100	1,400	1,700	2,000	2,400	2,700	3,000	3,500	4,100	4,700	5,200	5,900	6,000		
1-1/8	1,000	1,200	1,500	1,800	2,200	2,500	2,800	3,300	3,800	4,400	4,900	5,500	6,000		
1-3/16	1,000	1,200	1,400	1,700	2,100	2,400	2,700	3,100	3,600	4,200	4,600	5,200	5,700	6,000	
1-1/4	900	1,100	1,400	1,600	2,000	2,200	2,500	2,900	3,400	3,900	4,400	4,900	5,400	6,000	6,000
1.310	800	1,000	1,300	1,500	1,900	2,100	2,400	2,800	3,200	3,700	4,100	4,700	5,200	5,800	6,000
1-3/8	800	900	1,200	1,500	1,800	2,000	2,300	2,600	3,100	3,600	3,900	4,500	4,900	5,500	6,000
1-7/16	800	900	1,200	1,400	1,700	1,900	2,200	2,500	2,900	3,400	3,800	4,300	4,700	5,300	5,800
1-1/2	700	900	1,100	1,300	1,600	1,800	2,100	2,400	2,800	3,200	3,600	4,100	4,500	5,000	5,500
1.625	600	800	1,000	1,200	1,500	1,700	1,900	2,200	2,600	3,000	3,300	3,700	4,100	4,600	5,100
1.650				1,200	1,400	1,600	1,800	2,200	2,500	2,900	3,200	3,700	4,100	4,600	5,000
1-3/4				1,100	1,300	1,500	1,700	2,000	2,400	2,700	3,000	3,500	3,800	4,300	4,700
1-7/8				1,000	1,200	1,400	1,600	1,900	2,200	2,500	2,800	3,200	3,500	4,000	4,400
1.900				1,000	1,200	1,400	1,600	1,800	2,200	2,500	2,800	3,200	3,500	3,900	4,300

Note—Above pressures for minimum walls. For average walls use next lowest gage.

cost by specifying welded—rather than seamless—tubes.

Improved Quality Control

Refinements in production methods and quality control techniques have added to the uniformity, quality and acceptability of welded pressure tubing. Today, welded tubes are completely concentric, of uniform ductility and of unquestionable weld quality.

Carbon steel, electric - welded pressure tubes are presently being used in heat exchangers and condensers for the chemical process industries and in refrigeration applications. They are operating in marine and stationary boilers at pressures as high as 2,700 psi. Specifically they are used in boiler, water wall, supply, riser, superheater, economizer, reheater, and attemperator applications within the limits of manufacturing and temperatures to which carbon steel tubes may be subjected.

Today's electric-welded tubing is not the same species as that associated with its poorly regarded relative of the 1940's.

Fabrication Process Details

How is this new, dependable welded tubing being manufactured? What are the special quality control techniques that are now being used?

To answer these questions, here's a brief rundown of how a strip of steel becomes a welded tube in our Alliance plant.

It all begins with the receipt of truck and rail shipments of coiled strip steel from our suppliers. When the strip arrives at the plant, an inspector from the metallurgical department cuts samples from each heat, size and shipment. Samples are checked for hardness, thickness and width.

In the metallurgical laboratory, samples are then sectioned for chemical analysis to make certain that the steel complies with end-use applications. Sections are then macroetched and examined for pattern structure which may be present in the strip such as undue segregation, pipe or pockets in the metal, seams and slivers. Coils showing such defects are rejected for heat exchanger use.

After scale-breaking and pickling, coils are also examined visually for surface defects, thickness and width measurements. Those that show physical defects are rejected.

Next, the coil is fed to a leveler for flattening. The ends of the strip are then cut square and butt welded to the end of the preceding and following coils to form an endless strip which is run into a recessed floor loop.

Feeding from this loop, the strip enters the rotary slitter in line with the welding mill, where it is edge-slit to an exact and constant width. Thus, a fresh edge free of rust and mechanical damage is produced seconds before welding.

Contour Shaping

The strip enters the forming mill, where contour shaping takes place. A series of roller dies, in graduated size, shape the strip into the form of a hollow cylinder. The two edges of the strip are forced together under the welding electrodes, which ride on the upper surface of the formed tubing on both sides of the seam.

The roller dies which form the tubing from the flat strip must be accurately contoured to attain reproducible results. The contours are checked on each roller die after every long run of a size, and when necessary, the roller dies are brought back to their proper shape.

In the resistance welder, whether 360-cycle or radio frequency, electrodes contact the upper surfaces of the formed tube on either side of the seam, while pressure rolls provide the pressure required to bring the edges of the tubing into contact. The electrical resistance to the flow of current across the joint causes the formation of intense localized heat, and under pressures of electrodes and front and back squeeze rolls, the strip edges are welded together.

Ultrasonic Flaw Detection

The outside and inside beads formed in the welding operation are removed by special cutting tools in the continuous operation as the tubing emerges from the welding mill.

At B & W we use an ultrasonic flaw detector on each welding mill immediately after the cooling trough and ahead of the sizing mill. We station an inspector at each mill at all times to check weld quality by means of this ultrasonic inspection device, deformation tests and fluorescent magnetic particle examination.

After leaving the welding mill, we size and straighten the tubing and then cut it to the desired mill length. Tubes that contain the strip joints are discarded at the welding mill.

Next step is to "homogenize" the grain structure in a controlled-atmosphere furnace and apply a rust-retardant oxide finish to the surface of the tubing.

Mechanical and Pressure Tests

Emerging from the normalizing furnaces, the tubes are rotary straightened, hydrostatically tested, and discharged to the cutoff machines, then end-faced and chamfered exactly to the required length.

ERNEST W. ALLARDT is chief engineer at the Alliance, Ohio, plant of the Tubular Products Div. of Babcock & Wilcox Co. He's a registered Professional Engineer (Mechanical) in Ohio and a Fellow of ASME having served that organization as a regional vice president and as a member of the national executive committee.

Allardt has designed a number of welded-tube mills now operating in Europe and the U. S. and holds numerous patents covering welded-tube mill equipment.

Coupons cut from the ends of the tubes are subjected to the merciless mechanical tests indicated in the photographs on p. 136.

All heat exchanger tubes are subjected to hydrostatic test pressures which generally range from 1,000 to 6,000 psi. as required. Test pressure used is governed by the diameter and wall thickness of the tubing and is the maximum allowed by specification (see table of test pressures on p. 137).

Final inspection includes surface examination, micrometer check of dimensions and a length-check.

Cold Drawing Is Next

Tubes are cold-drawn when:

1. The inside diameter is too small to permit welding bead removal by cutting.
2. When wall thickness is too heavy to be readily formed in the diameter desired.
3. When extremely close tolerances are required.

Cold-drawn tubes are given the same sequence of operations through normalizing. The ends of the tubes are reduced in diameter to permit entry into the cold-drawing die. They are then cleaned, pickled, a phosphate coating is applied as a lubricant base and a lubricant is applied.

The prepared tube is partially inserted through the die with its pointed end projecting. If wall thickness must be reduced, a mandrel attached to a bar is placed in the tube from the opposite end, and the pointed end is gripped by the carriage. The carriage hook is engaged in the traveling chain of the draw bench, and the tube is pulled through the die between the die and the mandrel.

Where diameter alone is to be reduced, the mandrel is omitted.

The tube is then normalized in the controlled-atmosphere furnace, repickled and relubricated and the cycle of operations repeated until the desired size is obtained.

Final operations after cold drawing consist of normalizing the tubes, straightening, cutting, coupon testing, de-burring, hydrostatic testing and final inspection before shipping.

Details of Ultrasonics

Since the application of immersed ultrasonic inspection to provide a continuous check on the quality of the weld—the most important variable to be controlled—is relatively new, let's pause now to take a closer look at it.

In ultrasonic detection of flaws, high-frequency sound is generated by electrically exciting a transducer, or "search crystal." The sound is beamed into the metal under test, and is echoed back to the transducer by any defects. This causes the transducer to vibrate, generating electric current which ultimately shows up on an oscilloscope. The echoes are timed, permitting the defect to be located by referring to the point at which the sound entered the metal.

Because air is a poor conductor of sound, best results are obtained by putting the ultrasound into the metal through a coupling medium such as water.

Whenever a defect greater than the established limit shows up, an alarm circuit lights warning lamp on the oscilloscope, activates a horn at the mill inspectors' stations and trips a spray gun which marks the tube at the exact location of the defect.

The marked area is investigated to determine the extent and type of defect. The lot of tubes is tagged for special checks, including magnetic particle inspection, visual inspection, deformation tests and supplementary ultrasonic inspection.

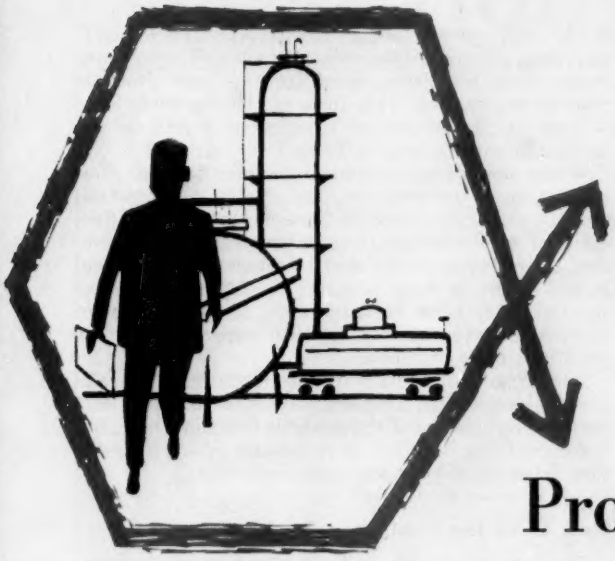
What About Costs

Now that you have some understanding of the improved manufacturing processes and quality control techniques that are being used to guarantee the ability of welded tubing to do the required job, what about cost?

In this issue *CE* Cost File, p. 156, presents an up-to-date comparison of prices for welded tubes and their seamless counterparts. You'll note that in some cases the differential is almost 30% in favor of the specification of welded tubes.

However, there are many kinds and types of tubing on the market today. Tubes which may be ideal for one application may be completely unsatisfactory for another use. Designers of equipment must recognize this fact.

For optimum cost, service life, ease of fabrication, the designer must match the tube to the job.



Systems Engineering, Part 3

Process Development

After the reaction mechanism has been proved, analog computers help find process conditions for best reaction.

THEODORE J. WILLIAMS, Monsanto Chemical Co., St. Louis, Mo.

IN PART 2 (CE, Mar. 7, p. 131), our project engineer, Joe X. Smirk, called upon the systems engineering group of Quandary Chemical Co. to assist in process research for a plant to make *P*. The systems group responded by dove-tailing its contributions with those of the research chemists.

Basing their program on what the lab men had discovered in preliminary experiments, the joint group decided that five isothermal batch reactions would provide sufficient data to develop a kinetic model. These data were presented in plots of reaction component compositions *vs.* time.

Then, in initial examination of these data, the systems group assigned reaction characteristics that had to be fulfilled in any reaction mechanism proposed. This narrowed the area of investigation to two probable choices from the many possible schemes. These schemes consisted of chemical reactions, differential equations governing the mechanism, assumptions about intermediate products and stoichiometric relationships of the components.

From the stoichiometry, as much as possible was gleaned about the intermediate products composition and make-up for each scheme. During this analysis several contradictions and discrepancies arose for resolution. Carrying the paper-and-pencil work as far as possible, the systems group again called in the chemical research department for some bench work.

With the lab results in hand, and the mechanism analysis complete, the systems group put the problem on the analog computer to determine kinetic coefficients for each step of the chosen mechanism. This work was facilitated by selecting preliminary kinetic coefficients from the composition *vs.* time patterns that had been worked out. The reaction scheme was proved by solving on the computer the set of simultaneous differential equations describing the scheme. Output of the computer was curves of composition *vs.* time which could be compared to the original lab data for best fit.

To obtain the computer solution, values for the kinetic coefficients were "cranked in," so that when the computer output best matched the experimental data the coefficients were easily determined. A semilog plot of these coefficients *vs.* the absolute temperature

Coefficients for Reaction Scheme—Table I

The Arrhenius expression is

$$k_i = A_i e^{-B/T}$$

For k_1 (basis: 1 lb. of A or B),

$A_1 = 5.9755 \times 10^9$/hr., wt. fraction

$B_1 = 12{,}000$ R.

For k_2 (basis: 1 lb. of B),

$A_2 = 2.5962 \times 10^{12}$/hr., wt. fraction

$B_2 = 15{,}000$ R.

For k_3 (basis: 1 lb. of C),

$A_3 = 9.6283 \times 10^{15}$/hr., wt. fraction

$B_3 = 20{,}000$ R.

Prove Reaction Scheme 1—Table II

Differential Equations

$$dA/dt = -k_1[A][B]$$
$$dB/dt = -k_1[A][B] - k_2[C][B]$$
$$dC/dt = k_1(M_C/M_A)[A][B] - k_2(M_C/M_B)[C][B] - k_3[C][P]$$
$$= 2k_1[A][B] - 2k_2[C][B] - k_3[C][P]$$
$$dE/dt = k_2(M_E/M_B)[C][B] = 2k_2[C][B]$$
$$dP/dt = k_2(M_P/M_B)[C][B] - k_3(M_P/M_C)[C][P]$$
$$= k_2[C][B] - 0.5k_3[C][P]$$
$$dG/dt = k_3(M_G/M_C)[C][P] = 1.5k_3[C][P]$$

where molecular weight of A, B and P is 100, of C and E is 200 and of G is 300.

Magnitude and Time Scaling Equations

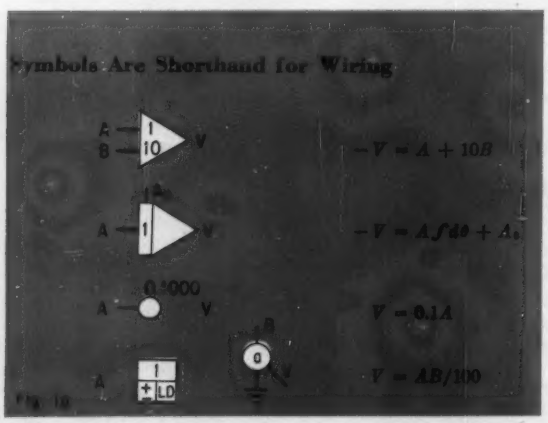
$[A] = A$ $\quad$ $[G] = G$
$[B] = B$ $\quad$ $C' = C'$
$[C] = C$ $\quad$ $P' = P'$
$[E] = E$ $\quad$ $t = 0.01\theta$
$[P] = P$

Machine Equations

$$dA/d\theta = -0.01k_1AB$$
$$dB/d\theta = -0.01k_1AB - 0.01k_2CB$$
$$dC/d\theta = 0.02k_1AB - 0.02k_2BC - 0.01k_3CP$$
$$dE/d\theta = 0.02k_2CB$$
$$dP/d\theta = 0.01k_2CB - 0.005k_3CP$$
$$dG/d\theta = 0.015k_3CP$$

Potentiometer Settings

Pot 1	k_1/1,000	Pot 7	0.4000
2	k_2/1,000	8	0.4000
3	k_3/1,000	9	0.3000
4	A_0/100	10	0.5000
5	B_0/100	11	0.4000
6	0.4000	12	0.3333



reciprocal showed consistency over a wide temperature range—thus bolstering proof for the most probable reaction mechanism. This form of plotting coefficients —based on the Arrhenius expression—yields the information summarized in Table I for our case.

Where such physico-chemical considerations as solubilities, mass transfer, etc., are vital to the kinetics, they too can be evaluated by these methods. The differential or algebraic equations describing such phenomena are included in the model prepared for the computer. Thus, a mass transfer coefficient is another constant that must be determined by comparison of successive computer results with experimental data until best fit is obtained.

Isothermal batch data were used in this case to evaluate the kinetic parameters. Absence of such data doesn't preclude use of the methods described here, but it considerably complicates it because of k's temperature dependence (the Arrhenius relations).

How Does the Computer Do It?

You may be curious, as Joe Smirk was after receiving the kinetic information from the systems group, about how the analog computer can so readily handle the solution of simultaneous differential equations. Fig. 1 shows the actual computer circuit that was set up by the systems group to evaluate reaction scheme 1. Let's consider briefly how we go from the reaction problem equations to the computer circuit. (For a more detailed discussion of analog methods in kinetics, see Ref. 3.)

In Table II, the differential equations governing the mechanism of scheme 1 are repeated with molecular weights substituted as appropriate. The general-purpose electronic analog computer circuit voltages correspond to process variables. But computer circuitry limits the voltages to, say, ±100 v. so that problem equations must not produce voltages outside this range. In general, this limitation requires magnitude-scaling of dependent variables. Circuitry response also sets limitations on computing time, though for our case we compute 36 times faster than real time.

Differential equations that are actually put on the machine are related to the problem equations, therefore, by scaling equations shown in Table II. When substituted in the problem equations, these scaling factors produce the machine equations also shown. After the scaling for our problem was complete, the computer circuitry wiring diagram, Fig. 1, was prepared. Symbols in Fig. 1a show circuit components used in this particular diagram. They are, in order, the summing amplifier, integrating amplifier, potentiometer and servomultiplier. The wiring diagram guided patchboard wiring to get the required circuit.

Coefficients of machine equation terms determine potentiometer settings and problem gains. (Problem gain factor is shown on the input side of each amplifier; it multiplies input voltage.) Pot settings for the problem are shown at the bottom of Table II. Note that k_1, k_2 and k_3—the kinetic coefficients we are trying to determine to prove the mechanism—are put into the circuit with Pots 1, 2 and 3. Without rewiring the problem circuit, these pot settings can be changed by the computer operator as easily as you change volume on your television set.

The output (apex) end of each amplifier component

This Wiring Diagram Shows Computer Circuit to Prove Reaction Mechanism

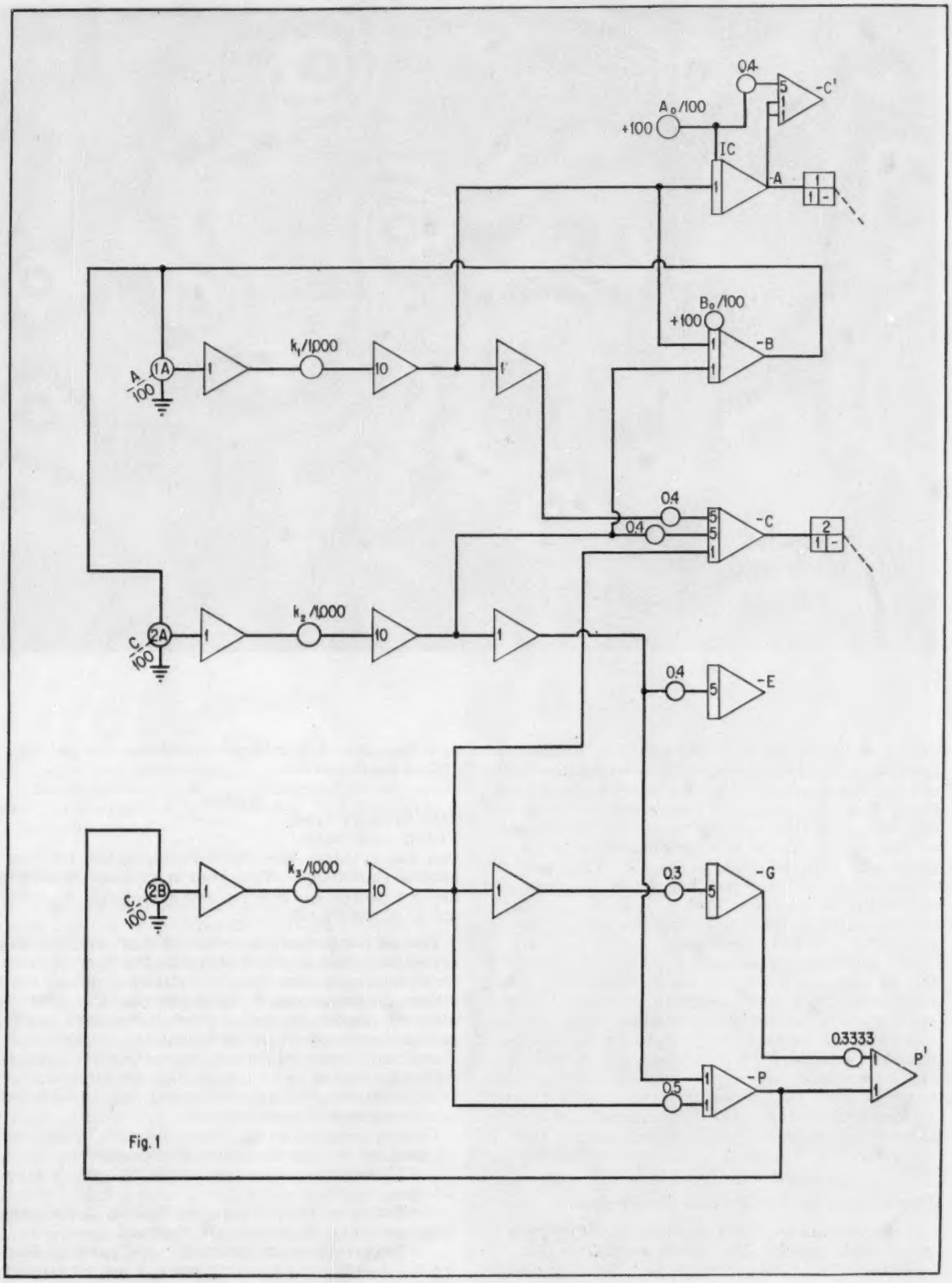
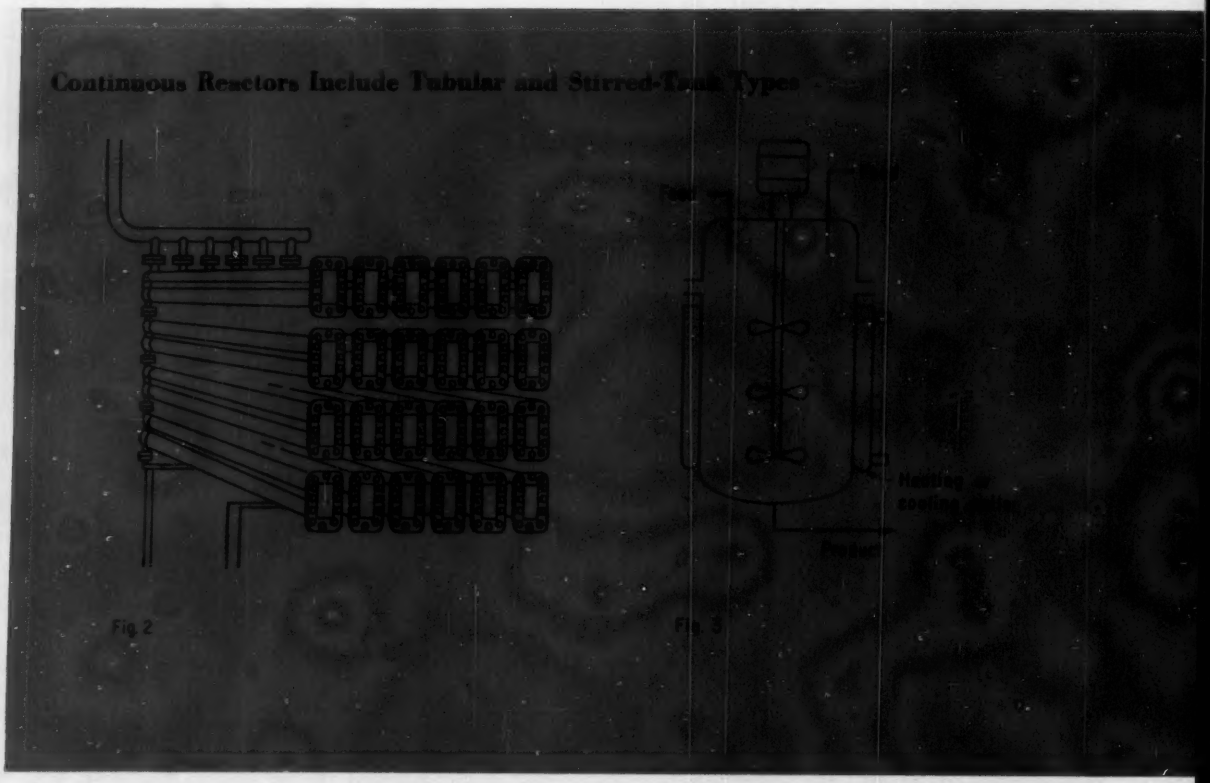


Fig. 1



can be input for other components, but, as noted on the diagram of Fig. 1, eventually the outputs are the quantities we seek—in this case, the various compositions. These composition outputs—continuous electrical functions of time—can be connected to x-t recorders so that we get curves directly comparable to the experimental data collected in the lab. These are the curves which are matched by best fit to prove the mechanism, as we did in Part 2. When the curves fit, the pot settings for the kinetic coefficients directly give values for those coefficients.

The problem of evaluating a complex reaction system of this magnitude by hand is generally insurmountable. Much simpler systems require a tremendous amount of calculation.[3] A trial-and-error solution, using various kinetic coefficients, would nearly always prevent examining the mechanism in step-wise fashion; instead, the over-all rate constant approach might be used. One of the important contributions of systems engineering is use of new techniques such as these to look closer at the important reaction steps in processes that require it.

Use Computer for Process Development

It dawned on our project engineer that if the systems group could provide the kinetic coefficients for this complicated reaction system so fast, then they might give him more help in determining best reaction conditions for the process.

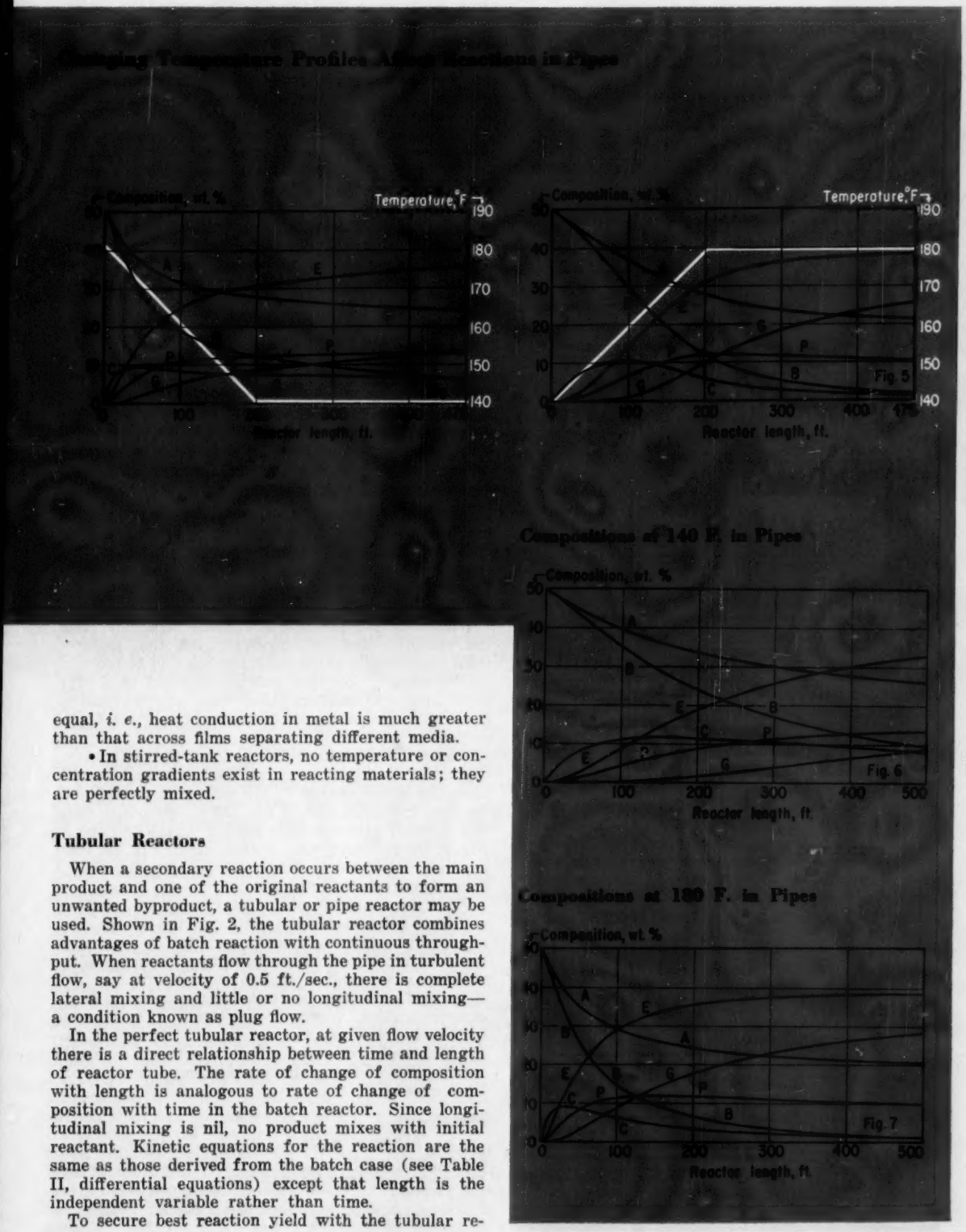
MEMO

TO: Systems Group
FROM: Joe Smirk
Can you evaluate this reaction mechanism for best process conditions? What kind of reactor should we use in a continuous process, and how should we operate it in the plant?

Just as computers help establish most probable reaction mechanisms, so can they ease the work of process development—determining optimum reaction conditions for the process.[4] Before showing the effect of different reactors on our process system, let's briefly consider methods of reactor analysis by computer. Since Smirk indicated the process was to be continuous, we'll consider the two most common reactor types for this processing—the tubular (pipe) reactor and the continuous stirred-tank reactor.

Certain assumptions are commonly made in analysis of chemical reactor dynamics. For example,

- There is no volume or density change upon reaction.
- Individual heat transfer coefficients of temperature-controlling exchanger are constant.
- Temperatures of exchanger wall and of heat storing metal parts are uniform but not necessarily



equal, *i. e.*, heat conduction in metal is much greater than that across films separating different media.

• In stirred-tank reactors, no temperature or concentration gradients exist in reacting materials; they are perfectly mixed.

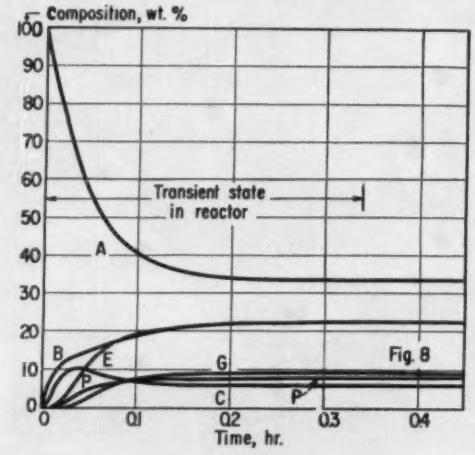
Tubular Reactors

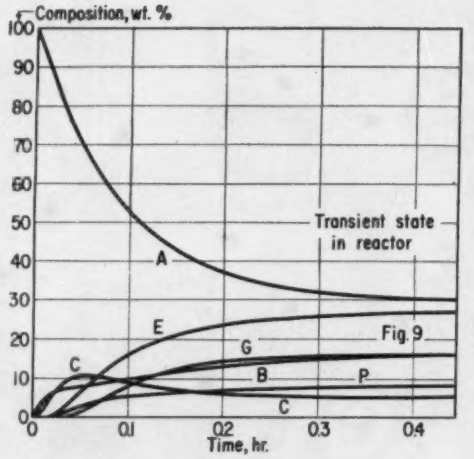
When a secondary reaction occurs between the main product and one of the original reactants to form an unwanted byproduct, a tubular or pipe reactor may be used. Shown in Fig. 2, the tubular reactor combines advantages of batch reaction with continuous throughput. When reactants flow through the pipe in turbulent flow, say at velocity of 0.5 ft./sec., there is complete lateral mixing and little or no longitudinal mixing—a condition known as plug flow.

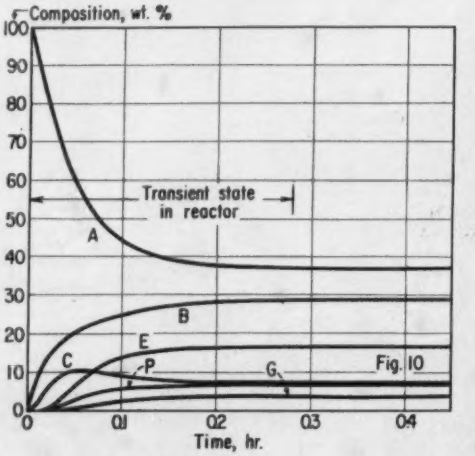
In the perfect tubular reactor, at given flow velocity there is a direct relationship between time and length of reactor tube. The rate of change of composition with length is analogous to rate of change of composition with time in the batch reactor. Since longitudinal mixing is nil, no product mixes with initial reactant. Kinetic equations for the reaction are the same as those derived from the batch case (see Table II, differential equations) except that length is the independent variable rather than time.

To secure best reaction yield with the tubular re-

Stirred-Tank Reactor Composition Curves







actor, we must maintain the same temperature profile as in batch operation for a particular reactant mass. The proper profile is usually obtained by making the reactor tube an inner tube of a concentric, multi-section heat exchanger. The temperature profile is expressed, as in Figs. 4 and 5, as a specific temperature-length distribution along the tube.

Figs. 4 and 5 show the effects on composition in our case of two different temperature profiles in a tubular reactor. Figs. 6 and 7 show the composition patterns which would exist in tubular reactors under isothermal conditions. In all cases, fluid velocity is assumed to be 0.7 ft./sec. The chief drawback of the perfect tubular reactor is that the turbulent flow requirement sometimes demands an enormously long pipe if the reaction is slow. And unfortunately many reactions are slow.

Continuous Stirred-Tank Reactor

Fig. 3 illustrates the continuous stirred-tank reactor. To define concentrations of the various chemical species that enter, leave or take part in the reaction, we can write a material balance for each reaction component. For example, the following summarizes gains and losses of component Z with time:

$$d[Z]_s/dt = (F_{in}/V)[Z]_{in} - (F_s/V)[Z]_s - kf[Z]$$

Differential equations can also be written to summarize the generation and transfer of heat in the reactor. Unlike the batch and tubular reactors, control of this reactor means establishing and holding that temperature that assures maximum economic yield of the desired product.

When reaction products are easily separable from the reactants and no subsequent reaction involves these components, unreacted materials may be recycled to the reactor. We thus obtain the effect of a very large number of reactors indeed with only one reactor. Such an arrangement is, of course, commonly found in process practice.

Figs 8, 9 and 10 show several trials of reaction conditions in a continuous stirred-tank reactor. In each case, the initial charge to the reactor is pure A and the feed is 50% A, 50% B. At 180 F., compositions of Fig. 8 result with residence time of 0.0484 hr.; and in Fig. 9, the residence time is doubled. In Fig. 10, compositions are based on the lower residence time and a lower temperature, 160 F.

All these composition patterns based on material and heat balances are the output of the analog computer. By using the analog computer, a very wide range of reaction conditions can thus be investigated without a very large capital expenditure for pilot equipment and outlay for operating manpower in direct experimentation. Since the reaction mechanism used for these evaluations was theoretically derived, a reasonable number of experiments is necessary to verify applicability of the mechanism for the range of conditions covered.

REFERENCES

1. Corrigan, T. E., Kinetics of Homogeneous Reactions, *Chem. Eng.*, Sep. 1954, p. 216.
2. Corrigan, T. E., Young, E. F., Reactor Design for Complex Reactions, *Chem. Eng.*, Jan.-Mar. 1956.
3. Parisot, P. E., Analog Computers, *Chem. Eng.*, Sep. 7, 1959, p. 137.
4. Williams, T. J., Chemical Kinetics and the Dynamics of Chemical Reactors, *Control Eng.*, July 1958, p. 100.

Guide to Industrial Viscometry

Some 56 viscosity measuring devices and 17 units are brought together here in tables and chart—bringing some order into this chaotic field of innumerable instruments and bewildering nomenclature.

ROBERT L. BATES, Chemineer, Inc., Dayton, Ohio

CHEMICAL engineers today, by virtue of the diversity of the chemical process industries, encounter a bewildering variety of viscosity units and an even greater array of devices for obtaining them.

Some 70 variations of 5 basic types yield over 40 different units for describing internal fluid friction.

While the special character of some classes of fluids and the need to satisfy certain industrial requirements must be recognized, such profusion of instruments and nomenclature for one fluid property is hard to rationalize. In times past this caused little distress since communication between various fields was at a minimum. But the rapidly developing "one world" of chemical engineering has, among other things, created problems in the language of rheology.

Viscosity seriously enters into analysis of fluid flow, heat transfer, agitation, instrumentation, and all other areas where the behavior of a liquid in movement can affect process results. In self-defense, the chemical engineer must come to terms with a subject once disdained as a tool of the control chemist.

Dimensional units must be mentioned briefly. Several *M, L, T,* expressions are possible for viscosity and many instruments simply produce an index value such as time. Universally used, though, is the poise or centipoise for absolute viscosity. When the instrument reading is a function of fluid density then we have kinematic viscosity and use the stoke or centistoke. Almost all viscometers operate in the laminar region of flow —a necessary prerequisite by virtue of the theoretical basis of design.

Rheology Rundown

Collection, interpretation and presentation of viscosity data invariably leads to the nomenclature problem of various classes of fluids. A very short course in rheology:

• Newtonian. At a given temperature these fluids have a viscosity independent of rate of shear and "one-point" viscometers are ample. Generally pure liquids, true solutions and dilute suspensions are Newtonian.

• Pseudoplastic. The majority of non-Newtonian fluids encountered will be in this category. They are characterized by a reduction in apparent viscosity as the rate of shear is increased. Academically, apparent viscosity is a myth but it is acceptable to the majority of rheologists. Obviously, an apparent viscosity value must be qualified by specifying the type of instrument and procedure used to obtain it.

• Thixotropic. This term is often used interchangeably with pseudoplastic, since a single-plot curve will show decreasing viscosity with increasing shear rate. However, thixotropy is actually a time-dependent property and a round-trip plot will yield a hysteresis curve. More simply, there is a time lag in the structural change of the material and different viscosity readings will be obtained at different stages of relaxation. Probably most pseudoplastic fluids exhibit some thixotropy but the time lag is not always measurable; nor is it of importance in every application.

• Dilatant. A type of consistency where particle suspensions are in a state of minimum voids. Any attempt to put the system into flow dilates the voids and thereby increases resistance to flow. While there is no known relationship between the two phenomena, it is convenient to think of this as an effect opposite to pseudoplasticity.

• Rheopectic. Another time-dependent non-Newtonian fluid which may resemble a dilatant fluid, since shear stress increases with time, at a constant shear rate.

Instruments by the Dozen

Very few instruments are pure expressions of a basic law and most operate on a combination of effects. For example, those embodying a rotor and stator with a close clearance are generally classed as a Couette or rotational type but actually approach the classical Newton concept of sliding parallel planes.

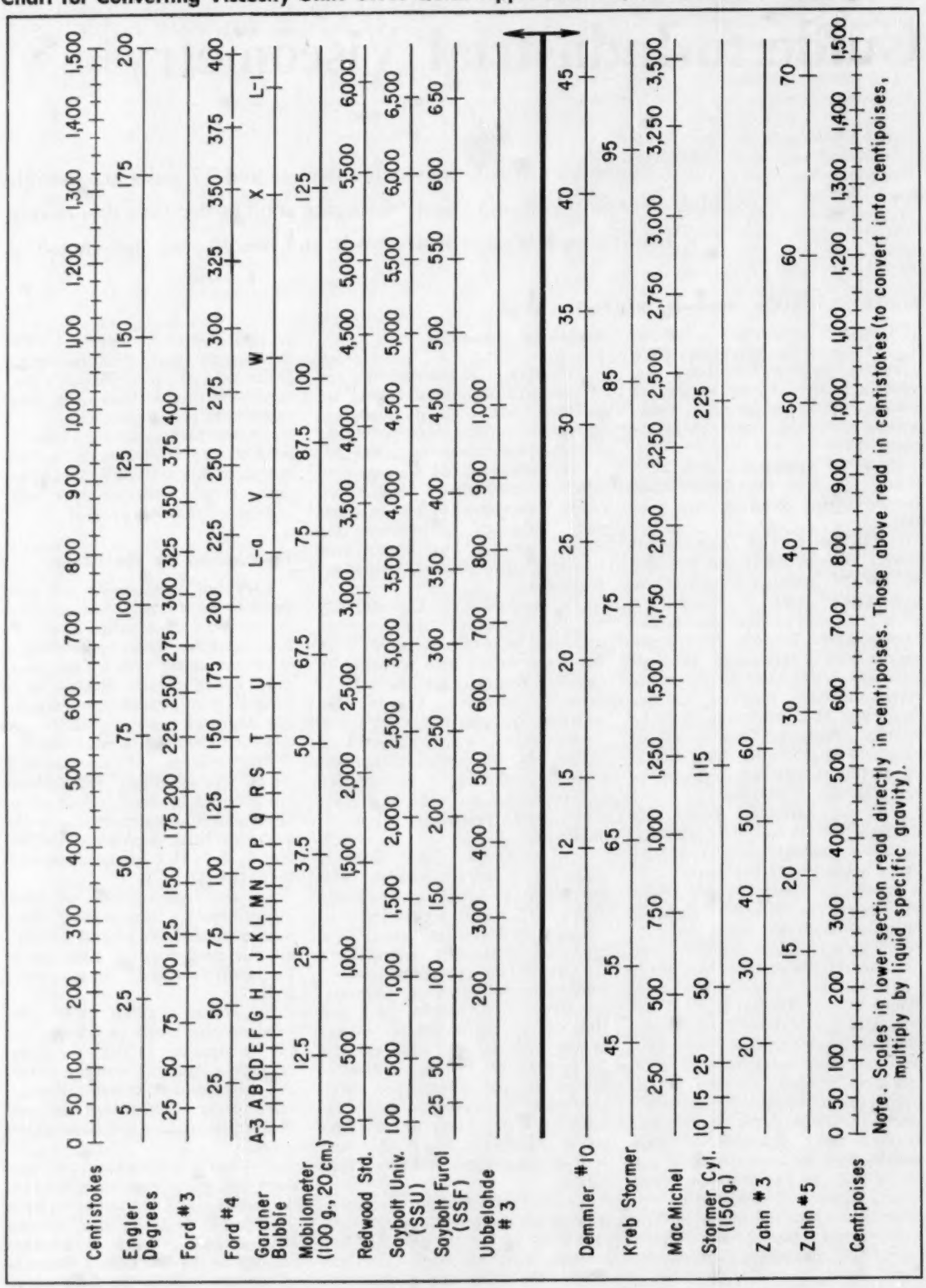
The system of classification which follows is one which seems best applied to grouping of available industrial instruments. In the following brief description the letters A, B, C, D, E are keyed in with the tables.

A. Poiseuille—Efflux or flow measurement instruments have been in general use longest and still are the most popular, particularly for quality control or one-point tests.

B. Stokes—Falling body viscometers are based on Stokes' law for a sphere falling vertically through a liquid. These are generally one-point instruments, although some piston modifications can vary the load to produce additional shear rates.

C. Couette—Rotational viscometers originally were coaxial cylinders. But many variations using a disk, paddle or prong in a test cup have evolved. Choice of whether the cup or the bob should rotate is of concern only to the designer of

Chart for Converting Viscosity Units Gives Quick Approximation, Not Absolute Accuracy



Industrial Viscometers: Types, Ranges and Applications

Viscometer	Viscosity Range (Centipoises)[a]	Viscosity Units	Multi-Shear[b]	Batch	Continuous	Major Area of Application
Atlantic	0.6 to 5,000	Seconds		X		Petroleum products
Cannon-Fenske	0.3 to 20,000	Seconds		X		Petroleum products
Fitz Simons	0.6 to 5,000	Seconds		X		Petroleum products
Hellige	0 to 28	Relative		X		Blood, plasma
Ostwald	0.4 to 16,000	Seconds		X		Petroleum products
Ostwald-Fenske	0.4 to 16,000	Seconds		X		Petroleum products
Ubbelohde	2 to 10,000	Seconds		X		Petroleum products
Barbey (Fr.)	1 to 4,000	C.c./hr.		X		Petroleum products
Demmler	4 to 20,000	Seconds		X		Varnish
Engler (Ger.)	1 to 1,500	Sec./200c.c. or relative deg.[e]		X		Tar, petroleum products
Ford cup	1 to 1,200	Seconds		X		Paint, varnish
Gardner One-Shot	—[d]	Seconds		X		Paint, varnish
Marsh Funnel	—[d]	Sec./946c.c.		X		Drilling mud
Redwood (Eng.)	1 to 5,000	Sec./50c.c.		X		Petroleum products
Saybolt	1 to 4,000	Sec./60c.c.		X		Petroleum products
Scott	—[d]	Sec./50c.c.		X		Oils, varnish, glue
Zahn	20 to 1,200	Seconds		X		Varnish, lacquer
Apex Pressure	100 to 6 x 10^6	Psi., seconds	X	X		Grease
Cox	0.5 to 30	Centistokes		X		—
Hallikainen-Shell	—[d]	—			X	Petroleum products, refinery
McKee Consistometer	100 to 6 x 10^4	pressure drop	X	X		Rubber, greases
Severs Extrusion	1 to 10^7	Psi., seconds	X	X		Plastisols, polymers
Gerin Comparator	—[d]	Relative		X		Engine oil
Hoeppler	0.01 to 250,000	Seconds		X		Gases, petroleum products
Ruska Pressure	—[d]	Seconds		X		High pressure (to 12,000 psi.)
Visgage	40 to 450	Saybolt U secs.		X		Lube oil
ASTM Timer Tube	400 to 100,000	Seconds		X		Paint, varnish, lacquer
Gardner Bubble	50 to 106,000	Relative		X		Varnish, oils, resins
Gardner Vertical	1,000 to 200,000	Stokes		X		Oils
Interchemical	60 to 15,000	Stokes		X		Oils
Gardner Mobilometer	to ASTM 360[c]	Seconds		X		Pastes, greases
Norcross	0.2 to 10^6	Centipoises			X	Solvent, starch, petroleum products
SIL Mobilometer	65 to ASTM 380[c]	Arbitrary number		X		Oil, greases

(Continued on next page)

the instrument. This class, by its inherent design, is amenable to variation of the rate of shear and good for non-Newtonian fluids.

D. Newton—Plane shear in the classic manner is not obtainable since the planes would have to be infinite in extent. But the physical principle is used in some special instruments.

E. Coulomb—Oscillational viscometers have existed in the past in the form of disks and cylinders but the only instruments now representing this class are those using ultrasonic vibration of reeds. Rate of damping is the effect measured.

Data on some 56 viscometers currently in industrial use are tabulated above and on p. 148. Some of the unit names are generic and available from many sources. Others will be recognized as recent proprietary developments. Grateful acknowledgment is offered here to the host of firms who contributed information for the summary.

The viscosity conversion chart lists some 17 of the more common units of viscosity. It can only be an approximation and is offered for use where quick conversion is more important than absolute accuracy.

ACKNOWLEDGMENT

It would be impossible to list names of all manufacturers and suppliers who contributed to this article. Most can be found listed in standard trade directories or equipment catalogues. However, the listing of some suppliers of instruments not found in usual directories might be useful. For instance: Hellige (Hellige, Inc.,

Industrial Viscometers: Types, Ranges and Applications (Con't.)

	Viscometer	Viscosity Range (Centipoises)[a]	Viscosity Units	Multi-Shear[b]	Batch	Continuous	Major Area of Application
 B-4 Float (Position)	F & P Viscorator	0.5 to 550	Saybolt U seconds			X	Petroleum prod., food
 C-1 Disk or paddle (Torque)	Brabender Viscograph	1 to 20,000	Centipoises		X		Food, coatings, paint
	Brookfield Synchro-lectric	0 to 1.6 x 10^5	Centipoises	X	X		General CPI
	Brookfield Viscome-tran	0 to 10,000	Centipoises			X	Paper coatings, starch cooking, food
	Haake Rotovisko	1 to 10^8	Centipoises	X	X	X	General
	Hallikainen Dow	— to 500,000	—			X	Polymers
	MacMichael	50 to 300,000	Arbitrary deg.	X	X		General
	Mooney Plastometer	— to 10^8	Deflection		X		Rubber
	Precision	100 to 250,000	—	X	X		Greases, paints, plastics
	Stormer (also cyl.)	1 to 100,000	Gm./arb.rpm. or sec./arb. rev.	X	X		General
 C-2 Concentric cylinders (Torque)	Baroid Rotary	5 to 269	Centipoises		X		Drilling mud, ceramic slips
	Corn Industries	—[d]	Gm.—cm.		X		Starch pastes
	Fann VG	1 to 300,000	Centipoises	X	X		Drilling mud, adhesives, ceramics
	Ferranti Portable	1 to 2 x 10^7	Centipoises	X	X		General
	Fisher Electro-viscometer	0 to 50,000	Centipoises		X		General
	Hagan High Shear	10 to 2,000	Dyne-cm.	X	X		Paper coatings, pigments
	Polarad RV-2	— to 800	Volts	X	X		Polymers, low shear
	Rao Birefringence	1 to 100	—	X	X		Molecular studies
	Sherwin-Williams	—[d]	Gm.	X	X		Paint brushability
 B Sliding plates (Distance)	Ferranti-Shirley	0 to 3 x 10^6	Arbitrary scale	X	X		Starches, gums
	Shell Sliding Plate	10^4 to 10^{13}	Microns	X	X		Asphalt
 E Vibrating reed (Frequency)	Bendix Ultra-Viscoson	0 to 50,000	Centipoises x gm./c.c.			X	Petroleum products, coatings, inks
	Ultrasonic Engr.	0 to 30,000	Centipoises x gm./c.c.		X	X	Petroleum products, paint, food

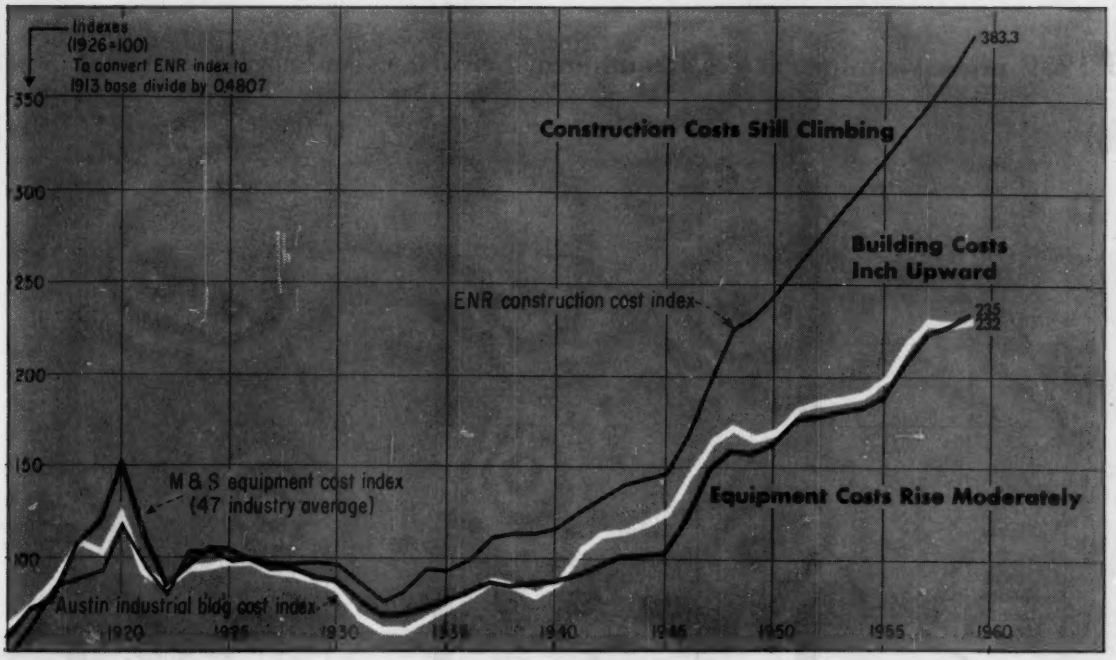
a. In many cases, requires several sizes to achieve full range.
b. Indicates usefulness for non-Newtonian liquids.
c. Cone penetration for semi-solids.
d. — notation means data not available.
e. Use of "relative" means viscosity stated as ratio to a reference fluid.

Garden City, N. Y.); Demmler (Westinghouse Electric); Marsh (Baroid Div., National Lead Co., Houston, Tex.); Zahn (General Electric); Apex (Apex Scientific, Orinda, Calif.); Cox (Cox Instrument Div., G. L. Nankervis Co., Detroit, Mich.); Hallikainen-Shell (Hallikainen Instruments, Berkeley, Calif.); Severs (Burrell Corp., Pittsburgh, Pa.); Gerin (Gerin Corp., Avon, N. J.); Ruska (Ruska Instrument Corp., Houston, Tex.); Visgage (L. C. Eitzen, N. Y. C.); Norcross (Norcross Corp., Newton, Mass.); Haake (C. A. Brinkman, Great Neck, L. I., N. Y.); Fann (Fann Instrument Corp., Houston, Tex.); Ferranti (Ferranti Electric, Inc., N. Y. C.); Rao (Rao Instrument Co., Brooklyn, N. Y.); Polarad (Polarad Electronics Corp., Long Island City, N. Y.).

REFERENCES

1. Barr, G., "A Monograph of Viscometry," Oxford Univ. Press, London, 1931.
2. Green, H., "Industrial Rheology and Rheological Structures," Wiley, New York, 1949.
3. "Power Test Codes, Instruments and Apparatus, Part 17, Determination of the Viscosity of Liquids," ASME, 1931.

ROBERT L. BATES is technical director of Chemineer, Inc., a position he has held since 1951. He is a graduate chemical engineer from Ohio State, a member of ACS, AIChE, American Oil Chemists Society, and a registered professional engineer in Ohio. A previous article (agitation) by Mr. Bates appeared in *Chem. Eng.*, Aug. 25, 1958.



No Slackening in Upward Cost Trend

Uninterrupted increases in equipment costs in the CPI during every quarter of 1959 brought the averages into new high ground for the year.

Charted above is a 47-industry average of equipment cost indexes prepared by the evaluation engineering firm of Marshall and Stevens, Inc., of Illinois, Chicago 4, Ill. Basis of each of the individual indexes upon which the average is based, and the method of weighting the average, are described on pages 124-6 of our November 1947 issue, in an article by the late R. W. Stevens, partner of the firm.

Also plotted on the same grid are the Austin Co.'s index of industrial building costs, and the *Engineering News-Record* index of heavy construction costs.

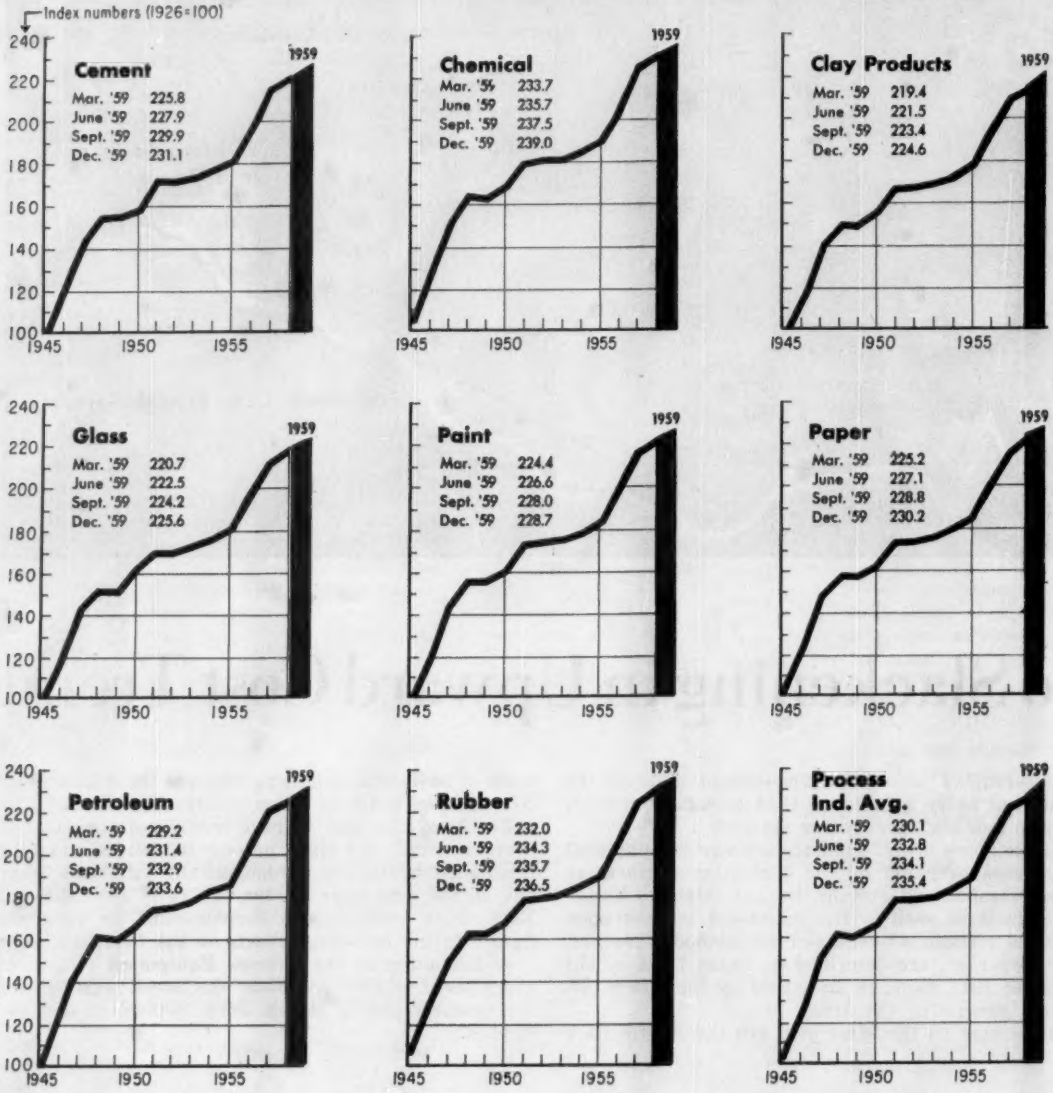
The M & S annual average indexes of comparative equipment cost for eight process industries and four related industries are chronologically tabulated below and on the next page. Extending from 1913 through 1959, these averages are supplemented by quarterly figures in the individual charts on the following page.

A tabulation in the Process Equipment section of every issue in 1960 will show the latest revisions for the quarters ending March, June, September and December.

Marshall and Stevens Annual Indexes of Comparative Equipment Costs, 1913 to 1959 (1926=100)

	1913	1916	1918	1920	1922	1924	1926	1928	1930	1932	1934	1935	1936	1937	1938	1939	1940	1941
Average of all....	57.9	62.8	109.7	153.3	85.5	105.3	100.0	96.5	87.0	66.1	74.6	78.0	81.6	88.3	84.4	84.3	86.1	92.6
Process Industries																		
Cement mfg.....	58.0	62.5	109.1	149.2	83.7	104.6	100.0	97.2	87.0	68.9	75.7	78.1	82.2	88.8	85.2	84.2	85.1	90.8
Chemical.....	59.0	63.0	111.9	150.5	82.5	105.6	100.0	96.9	82.0	77.6	75.4	78.5	82.5	88.2	84.4	83.4	84.3	93.3
Clay products.....	60.7	65.3	120.0	154.3	82.9	105.7	100.0	97.0	86.1	70.6	75.7	79.3	83.2	87.8	83.2	82.3	83.4	87.6
Glass mfg.....	58.7	63.5	112.1	151.1	83.7	101.9	100.0	95.9	86.6	69.4	75.4	78.5	82.6	88.0	83.4	82.5	84.0	88.2
Paint mfg.....	58.2	62.8	108.0	148.5	84.1	104.0	100.0	94.6	85.7	67.0	74.3	77.0	80.4	87.4	83.9	83.4	84.6	90.3
Paper mfg.....	60.4	63.4	111.8	152.6	83.1	105.6	100.0	96.8	86.5	67.2	75.4	78.5	82.7	88.1	84.8	83.7	84.8	90.5
Petroleum ind.....	58.9	64.1	113.0	151.5	82.7	106.0	100.0	97.1	86.2	70.1	76.0	78.7	82.6	87.8	83.3	82.1	82.5	88.2
Rubber ind.....	58.6	63.8	113.8	154.2	88.0	105.9	100.0	91.9	86.2	67.1	75.2	78.1	82.2	88.4	85.4	84.9	86.0	94.2
Related Industries																		
Elec. power equip..	59.1	64.3	114.2	152.2	83.6	106.0	100.0	96.9	86.1	70.1	75.5	78.7	82.7	87.9	84.3	83.7	85.3	90.5
Mining, milling.....	56.8	62.9	111.9	149.9	82.8	105.6	100.0	97.2	86.7	67.6	85.6	88.5	92.4	97.1	92.6	91.7	92.8	98.5
Refrigerating.....	59.3	63.2	113.5	153.5	83.9	96.1	100.0	97.0	86.4	70.0	75.4	78.9	83.0	87.5	83.0	81.8	82.7	89.0
Steam power.....	59.1	64.3	114.2	152.2	82.7	106.1	100.0	96.9	86.2	70.1	75.5	78.7	82.7	87.0	82.2	81.3	82.4	86.6

In 1959 process equipment costs continued their 10-yr. uninterrupted rise.



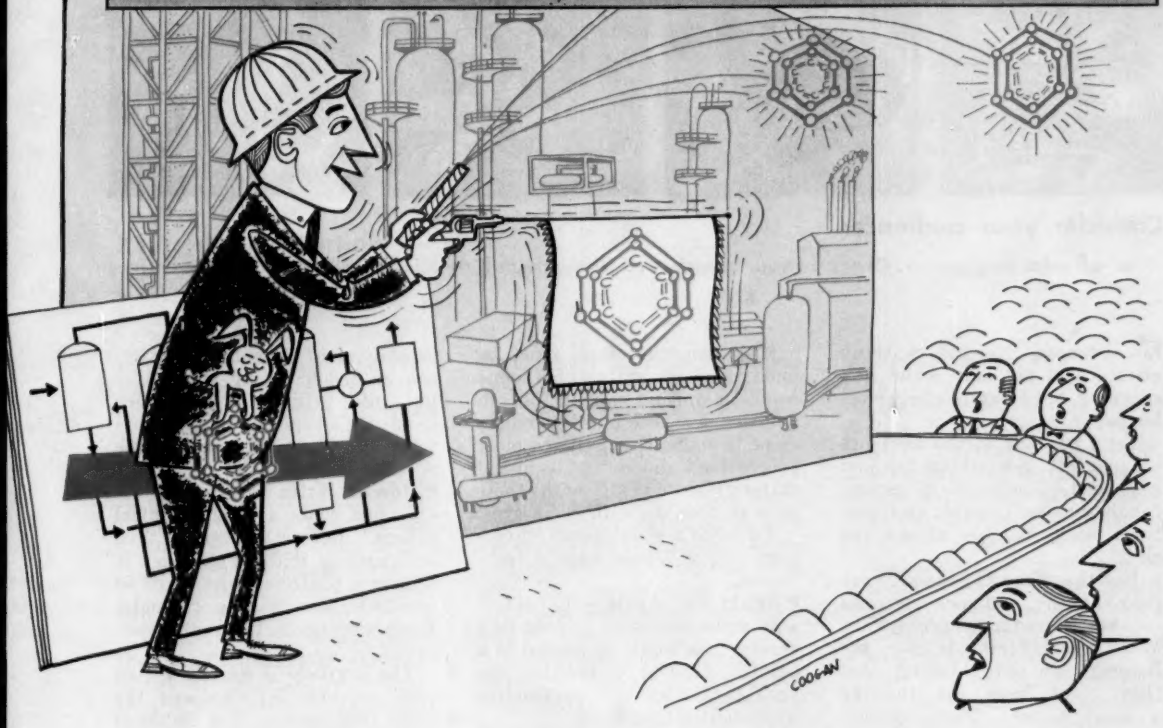
M & S Annual Indexes (continued)

	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Average of all....	99.6	100.5	102.4	103.4	123.2	150.6	162.8	161.2	167.9	180.3	180.5	182.5	184.6	190.6	208.8	225.1	231.3	234.9
Process Industries																		
Cement mfg.....	97.8	98.3	98.6	99.4	119.7	144.3	156.5	156.5	161.6	172.7	172.8	174.6	177.6	182.6	199.4	216.4	222.8	228.7
Chemical.....	102.0	103.1	105.6	106.5	126.8	151.5	164.5	164.5	169.6	180.7	181.1	183.1	186.2	191.5	209.1	226.5	232.3	236.5
Clay products.....	93.1	93.6	93.9	94.8	115.0	139.8	151.5	151.5	156.6	167.7	167.8	169.5	172.4	177.3	193.8	210.2	216.8	222.2
Glass mfg.....	93.7	94.7	96.5	97.4	117.6	142.3	154.6	154.6	159.7	170.8	171.0	173.0	176.0	180.9	197.5	213.8	219.3	223.2
Paint mfg.....	97.3	98.3	100.1	101.0	121.2	145.9	157.8	157.8	162.9	174.0	174.4	176.3	179.3	184.3	201.2	217.6	223.2	226.9
Paper mfg.....	97.5	98.7	101.3	102.2	122.4	146.9	158.1	158.1	163.2	174.3	174.7	176.6	179.6	184.6	201.5	218.2	223.8	227.8
Petroleum ind.....	95.2	96.7	100.0	100.9	121.6	147.1	160.9	160.9	166.0	177.1	177.6	179.7	182.8	188.0	205.4	222.2	228.0	231.8
Rubber ind.....	102.7	103.7	105.5	106.4	126.6	151.2	163.3	163.3	168.4	179.5	180.0	182.1	185.2	190.5	207.9	224.9	230.8	234.6
Related Industries																		
Elec. power equip..	96.5	97.5	99.3	100.2	122.9	150.0	166.1	166.1	171.2	182.3	182.8	185.0	188.0	193.3	211.0	229.2	235.2	239.0
Mining, milling.....	105.5	106.2	107.3	108.2	128.4	152.9	165.2	165.2	170.7	181.4	181.9	184.1	187.1	192.6	210.4	227.9	233.8	237.1
Refrigerating.....	95.8	97.0	100.2	101.7	125.7	163.2	176.6	175.8	185.2	200.1	200.7	202.8	204.8	211.6	234.3	254.2	260.8	265.1
Steam power.....	92.1	92.8	93.9	94.8	116.0	141.7	153.2	153.2	158.4	169.9	170.5	172.6	175.5	180.4	197.0	213.0	218.6	222.9

PRACTICE . . .

YOU & YOUR JOB

EDITED BY R. F. FREMED



That Next Talk You Have to Give

Will your audience wish they had stayed at home or will they agree that what you said was worthwhile? These 11 key points will help to make a good speech even better.

Lawrence Murphy, 500 Riverside Drive, New York 27, N. Y.

As the speaker steps forward, the audience waits quietly, expectantly. Or does it? Some people are yawning, and there's a slight noise of snoring. The listeners already know that they should have stayed at home.

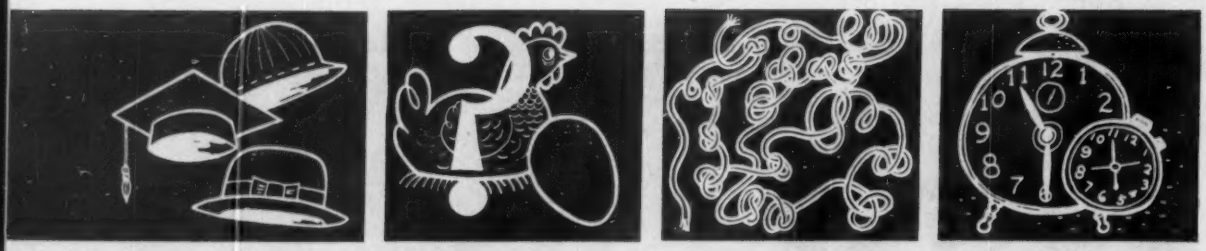
And yet this meeting is important. The papers tell about new work; the listeners might develop new ideas of their own, if the speakers were any good.

But even if they were excellent, why not stay away and read printed copies of the papers? Why suffer in miserable meeting-room seats?

There's no use arguing about the value of the printing press; but a talk does have some advantages over a printed article. Here stands a man telling about work he has done himself; print can't convey interest in his subject as effectively as his own voice (if his talk is any good at all).

And afterwards, the listeners can ask questions. They can discuss the subject with the speaker and with each other. This personal contact is essential; but if it's not there, then certainly the listeners might as well stay home and read the printed version.

To get personal contact, a speaker must always be aware of



Consider your audience:

Find out who they are . . . Organize your speech . . . Eliminate dull details . . . Budget your time.

his listeners. He has to think about them not only while he's speaking, but also while he writes his paper.

Let's go back to the audience we just left. Something has just happened. Everyone is awake, for the speaker is good; each gesture, each syllable shows his skill.

But then frowns gradually appear as the audience congeals into bewildered incomprehension. When the suffering is over, the listeners go out thinking that they must have sat through a good paper. They wonder, though, what the speaker was talking about, and they're mad at themselves because they don't know.

▶ **A Good Performance**—Was it a good paper? No, it was merely a good performance. The well-spoken words had meaning for the speaker and no one else. He made a mess of his subject.

For no matter how well a paper may be delivered, even an audience of specialists won't understand it unless the contents are as clear as possible. Clarity, however, is always a fast-flying ideal; and it is especially hard to catch in a talk, for a speech writer is easily tripped by the difference between written and spoken words.

And there is a difference. Written words, like paintings in a gallery, can be looked at for a long time. And you can go back and look at them whenever you want to. But spoken words, like notes of music at a concert, can be listened to for only a fraction of time. You can't go back and listen to them again. They are here and then gone.

A speech, therefore, must be understood instantly. This alone would be difficult enough; but, in addition, a speech must be understood by using the ears, and most people don't understand technical material as quickly with their ears as they do with their eyes.

To write a good speech, therefore, you will need special techniques.

▶ **Again and Again** — Considerably more repetition is used in a speech than would be needed in a printed article. Repetition assists memories and emphasizes important information.

And in a speech, connectives such as "therefore" and "however" are sometimes used at the beginning of sentences to emphasize relationships of information. In print, however, two-syllable connectives are usually buried (like the "however" in this sentence) so that the eye will not bog down on structural devices.

The first person "I" is often used to spark a talk. This is done partly to avoid a confusing third person construction such as: "The equipment that was described" (where? by whom?). If overused, "I" does become tiresome, but here and there it can simplify sentences; and it can increase the personal contact needed in a speech.

Today's sentence etiquette, however, forbids this use of the first person in a printed article, a rule that is based more on convention than logic. [And a rule that is not obeyed by this magazine.]

There is a difference between writing and speaking; and a good speech, because of its simple sentence structures and its repetitions of the subject matter, can be disappointing when it is put into print. On the other hand, an adequately written article can be incomprehensible when it is read aloud.

▶ **How to Write a Speech**—How does one write a good technical speech? Before answering this, let's assume that an engineer is seldom a politician who needs to persuade, nor is he a dramatic actor who needs to arouse emotions.

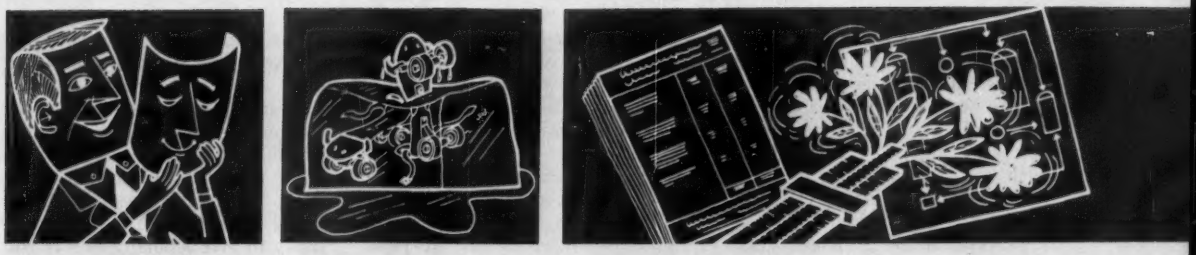
The engineer is usually a man who provides information; the main requirement of a technical speech is that it be easily understood. This doesn't mean that the speech should be understood by everyone, but it does mean that the speaker should try to make it understood by people who have knowledge and training similar (but not necessarily identical) to his own.

How does one write such a speech? Although there is no charted route to the heaven of comprehensibility, the following 11 suggestions have often been used as guides:

1. Organize the paper. Many technical papers fail because the speaker merely belches out the facts, hoping that his listeners by themselves will arrange the facts so that they make sense.

But unless you are composing an emotive love letter, each part of your writing should be carefully related to the other parts; a paper must have a definite shape.

Organization begins with a title, which is a simple statement of the subject. This subject is then broken into parts, and these parts are arranged in a step-by-



Keep their attention:
Talk and look right at them . . . Move meaningfully . . . Use visual aids for interest and clarity.

step report. Arrange the steps either according to time, or in accordance with cause and effect.

However, many subjects require other styles of organization. Material may be presented so that it goes from the known to the unknown, or from the near to the far (or the opposite), or from the whole to its parts (or the opposite) or from the problem to its solution.

Whatever the arrangement, the paper at this stage should be a list of summary statements, that is, an outline. This written skeleton is a good check on your own thinking, for there is no better way to see the development of your conclusions.

Once the outline is written, you can write the speech by merely enlarging upon each part of the outline. This not only saves time, but it also helps you relate the parts of the paper to each other.

And in a talk, this relationship of the parts must be explained and not merely implied.

Tell why you describe the high-pressure equipment. Tell why you talk about viscosity tests. If you do not, it could sound as if you were talking about several subjects at one time, and your listeners probably would give up trying to follow what you are saying.

2. Tell your listeners the purpose of your paper. This point usually sounds ridiculous to the speaker. He is so well informed about his subject that he tends to forget that others are not.

People deserve to know why you think your information is worth hearing.

3. Don't tell them everything. Do not make the speech a minute description of your subject. It should be more like an abstract than a laboratory notebook. Details should be left for the printed version.

4. Data are dull. You can't squeeze many figures into one short talk, so choose only those you really need. Summarize in your own words what the figures say, both those you show and those you don't.

Remember that you are usually just telling people about your work, you are not trying to prove every tiny detail; leave the complex proof for the printed article, and even there, much information must be taken on faith.

5. Summarize along the way. Tell what you are going to talk about; and after each main point summarize briefly what you have just said.

Here again is a device which is needed for good speaking but can be deadly in a written article. Talking requires more summary sentences than writing, because you cannot depend on your listeners to remember or to understand every word you say.

6. Double check for clarity. You can increase clarity by repeating a major point in other words, or by comparing one thing with another or by using examples and illustrations instead of generalities.

7. Use visual aids to explain what cannot be told by words alone. Visual material is needed when you talk about numbers, chemical structures, chemical reactions, mathematical derivations, unusual or complicated apparatus and the flow of materials.

Three-dimensional visual aids such as models are fine for a small conference room, but they're hard to see in a large lecture hall. Slides are the most common visual aids because of their clarity and low cost.

Preparation of good graphs and charts is a complete subject in itself. But if one word could be used as a planning guide it would be simplicity.

Not only is a simple slide easier for the audience to understand, but it's also easier for the speaker to explain.

Visual aids must be worked into the talk; that is, you must tell your audience exactly why you are showing them a graph—don't depend on a slide title to do this. You will also have to explain each detail of the visual material no matter how obvious it may seem to you, because your audience doesn't have time to study your drawings.

No matter how good your visual aids may be, they are only an accompaniment to your talk. They are never the main show. If you step back and let your slides do all the work, you are likely to leave a confused audience behind you.

8. Use simple, direct language. Avoid confusing your audience with this:

"The foregoing experiments are favorable indications that the molecules of the compound in the process of being studied did not under these conditions undergo a type of linkage which might be called crosslinking."

Instead, say "There was no evidence of crosslinking."

Read your paper aloud to yourself. Your speech pattern should sound almost as it does in conversation.

9. Define words that you think your listeners will not understand. By defining a word, you can assure yourself that both you and your listeners will be thinking about the same thing.

Individual laboratories, plants and offices tend to invent their own special names and abbreviations, and it's easy to forget that others will not know what they mean.

A word should be defined at the time you use it. Don't define a list of words at the beginning of your speech and expect your audience to remember the meanings when you finally get around to using them.

10. Summarize at the end of your speech. Just as at the beginning you told the audience the purpose of your paper, so at the end give them a short summary of what you said.

11. Find out about the audience you will be speaking to. How much do they know about your subject? If they are already well informed, your talk can be compact and short; but if they are not, you will have to use more explanations, definitions, descriptions.

People can be irritated if you speak above their heads, and they are usually insulted if you do the opposite and talk down to them. Fitting a paper between these two extremes is difficult.

▶ **After It's Written** — Suppose your paper is now written. What do you do with it?

Most authors will merely take their talks and read them to the audience. If you do this, you'll have to work hard to make the audience understand you. Your speech should be practiced until it falls as naturally from your mouth as do words in conversation; you must fight against making it sound lifeless. The script should be familiar enough so you can frequently look at the audience.

And the performance should be smooth, for the speaker who stumbles in reading his own words is a sorry sight.

Voice cues on the manuscript can help. Draw a circle around the most important words in each sentence to emphasize them. And you may want to place breath marks in the script. A mark, however, cannot tell you that words must be enunciated clearly.

If you speak from notes, your audience has a better chance of understanding you. This method not only lets you look at your listeners, but it also keeps your mind on what you're saying. For mind-wandering occurs in speakers as well as listeners. A speaker reading aloud can easily recite while his mind goes to sleep—it is no wonder the audience follows his example.

Thinking about what you are saying also makes it easier for you to talk naturally and thus avoid a reading-aloud monotone.

Memorizing a speech is fine if you have had some experience in doing it. If not, don't try. It's too easy to forget lines. A memorized speech, like a paper that is read, can be dull and stilted when the speaker concentrates on what word comes next instead of thinking about what he is saying. It is better to use some prepared notes.

▶ **Why Write It at All?**—By this time, you may wonder why a speech should be written at all if you are capable of delivering it from notes.

But writing is a necessary step, for it is the best way to organize the material. It also helps you clarify ideas and see weak points which you otherwise might overlook.

The written speech is the foundation of the speech notes, and these notes can be thorough or skimpy depending on your subject and your experience in public speaking.

If all the advice on good speaking could be reduced to one phrase, it probably would be *remember your audience.* There must be a person-to-person feeling in talking.

The best way to get this is to look at the listeners and to talk directly to them. It also helps if you avoid monotony in your delivery. Get expression by changing your speaking rate and by varying the volume and tone of your voice. Use pauses for emphasis and variety.

Speak loud enough for people to hear you. If there is a microphone, don't forget about it; and you will still have to enunciate with some care, for electronic reproduction makes the voice louder but not necessarily clearer.

Use illustrative material at the right time, and remove it when it is no longer needed. Avoid being immobile. You are more likely to give a boring talk if you stand stiffly without moving a muscle. You improve communication with your audience by using facial expression, gestures and changes in bodily tension.

However, every movement should have meaning. If you sprawl over the speaker's stand, sit on the lecture table or play with a piece of chalk, your audience may become more interested in what you are doing than in what you are saying.

In the final analysis, no matter how skillfully you deliver a talk, it can be a failure unless it is well organized and well written. But no rule of composition or public speaking can take the place of having something to say in the first place.

If you are interested in your subject, if you really want to tell other people about it and if you continually remember your listeners, then the suggestions offered in this article need only be guides to make a good speech even better.

LAWRENCE MURPHY holds academic degrees in chemistry, English and library science. At the present time he is taking additional graduate work in English and comparative literature at Columbia Univ. In addition, Murphy has served four years with Du Pont in Wilmington as a technical writer and editor.

CE COST FILE

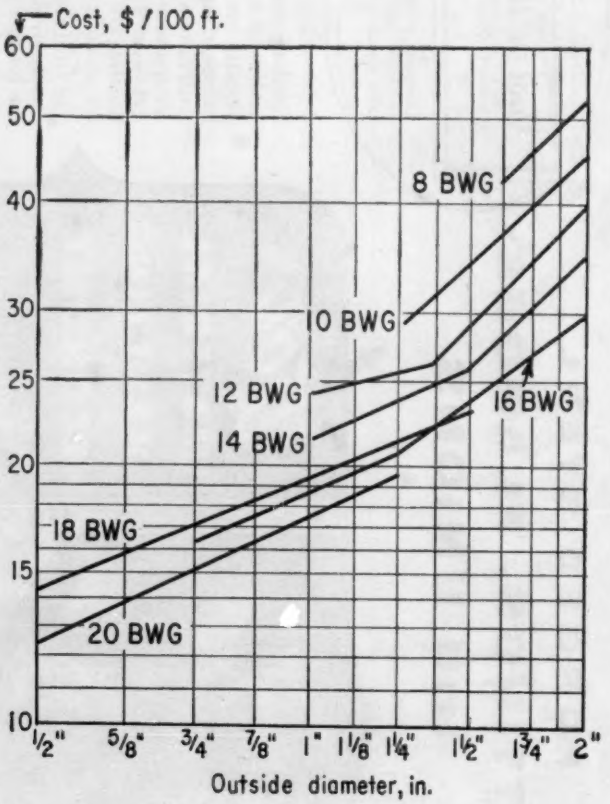
No. 28: Welded & Seamless Heat Exchanger Tubing

Tubular Products Div., The Babcock & Wilcox Co., Alliance, Ohio

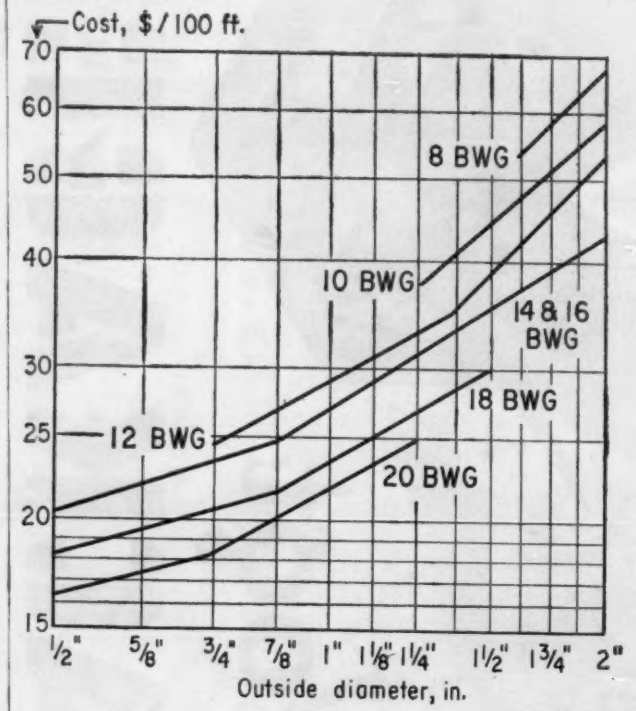
Basis of Cost

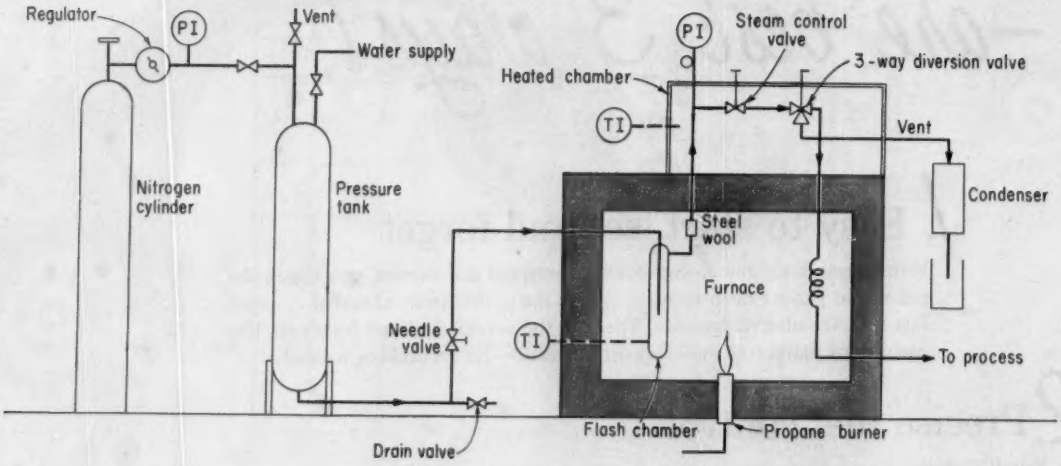
Following tubing costs are based on fob. mill prices, February 1960. Basis of the cost data, which are correlated in dollars/100 linear feet, includes: quantity — 40,000 lb. or ft.; lengths—cut lengths within range of 10-24 ft.; specification—seamless, ASTM-A-179 and welded, ASTM-A-214; wall thickness — minimum wall. Note that the ASTM specifications cover all sizes up to but not including 2 in. in outside diameter. Material of construction is low-carbon (maximum of 0.18%) steel.

Welded Tubing



Seamless Tubing





Pilot Steam Generator Boasts Control

For pilot plant work needing a few pounds/hour of low-pressure steam, here is a simple, accurate and readily controllable way to make it.

★ **Winner of the January Contest by**

M. S. Schwartz

United Engineers & Constructors, Inc., Philadelphia, Pa.

During some of our development work we had need for a generator of small quantities of low-pressure steam, the weight of which could be measured accurately. The diagram shows the setup.

The process required a gas-fired furnace for other purposes, so it was available for heating a flash chamber. What we then needed was a source of constant pressure and this we provided by loading our water-supply reservoir with controlled pressure from a nitrogen cylinder.

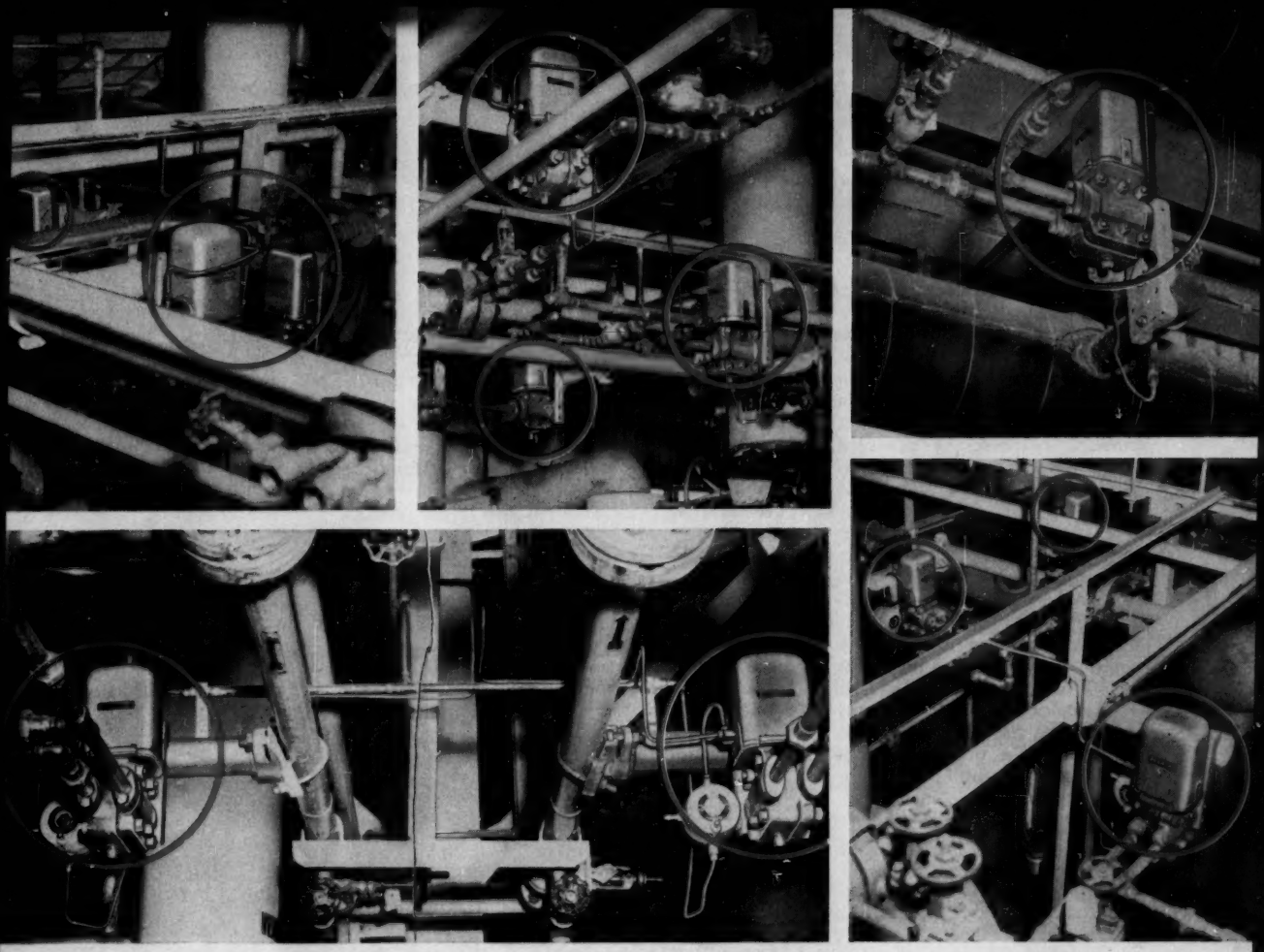
We made a pressure tank of 6-in. pipe, about 3 ft. long, with weld caps at each end. The desired steam pressure—10 to 35 psig. in our case—was secured by applying nitrogen pressure from a cylinder to the head of the pressure tank as shown in the diagram. The pressure was constant throughout each run but it could be varied easily by changing the nitrogen pressure.

In addition to the nitrogen cylinder and pressure tank, the system included a small flash chamber in the process furnace which was supplied with water from the pressure tank; a steam line and valving contained within a heated cabinet to prevent condensation; and a condenser to take care of excess steam.

To start the system we put a weighed quantity of water into

Here's Proof It Can Be Done

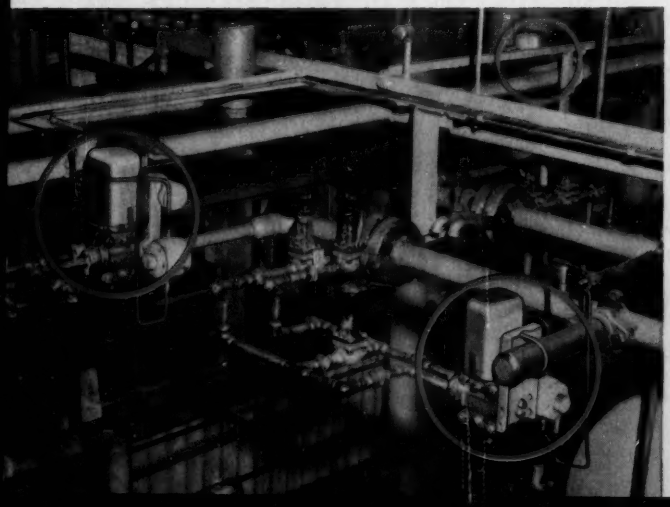
Mr. Schwartz's accompanying article is his second winner of our $50 monthly Notebook Contest in four months. In the past five years four other contributors, E. J. Gibbons, C. A. Lee, G. A. Lessells and P. C. Ziemke have all had two Notebook winners. You *can* win more than once! See details in the next issue, along with R. S. Smith's February winner on automatic protection of cooling water supply.



A few of the more than 100 Foxboro d/p Cell Flow Transmitters installed at Missouri Chemical Works of Hercules Powder Company, Louisiana, Missouri.

Hercules' Missouri Chemical Works reports:

"Foxboro d/p Cells* always accurate . . . never need re-calibration"



At Hercules Powder Company's 540-acre Missouri Chemical Works, there are over 100 Foxboro d/p Cell Transmitters in operation today — providing high-speed flow measurement and transmission throughout the ammonia, formaldehyde, methanol and pentaerythritol plants.

"Reliability is the big thing," according to Hercules instrument engineer J. J. VanSchaik. "We can install a Foxboro d/p Cell and forget it. Once it's calibrated, we know it'll stay that way. We never even stock spare parts."

Hercules especially likes the Foxboro d/p Cell for flow control. "Gives us closer control," says instrument engineer H. McCombie. "Eliminates one possible source of inaccuracy and maintenance trouble in the control loop."

Let Hercules' experience be your experience — with Foxboro d/p Cell Transmitters as the basis for your control system. Write for full details in Bulletin 13-11A. **The Foxboro Company, 364 Neponset Avenue, Foxboro, Massachusetts.**

*Reg. U. S. Pat. Off.

FOXBORO
REG. U.S. PAT. OFF.

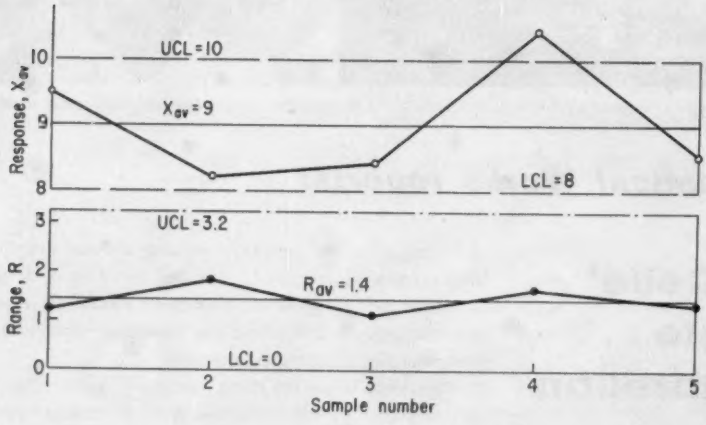
FIRST IN FLOW

the pressure tank. With the furnace started, when the flash chamber temperature reached 400 F. and the heated cabinet temperature reached 275 F., we cracked the needle valve in the line from the bottom of the pressure tank, allowing a small quantity of water to enter the flash chamber. As the steam pressure built up, we opened the needle valve gradually until the steam pressure reached the pressure set on the nitrogen cylinder. After this, the needle valve could be opened wide.

The flash chamber was a piece of 1-in. pipe, about 12 in. long and capped at both ends, with a piece of ¼-in. pipe extending several inches through the top cap into the chamber as an inlet. This pipe was blanked off at the bottom and drilled with several small holes to form a spray against the flash chamber wall. A piece of ½-in. pipe formed the outlet, near the top of the chamber. In the vertical section of this outlet we packed steel wool to function as an entrainment knockout.

We used this system for quantities of steam ranging from 0.03 to 2.0 lb./hr., although larger quantities could have been made. Control of the steaming rate depended on the setting of the steam control valve in the heated cabinet. Keeping this cabinet at 275-300 F. prevented condensation.

To keep an accurate account of the steam used we adopted the following system: Water was weighed into the pressure tank before a run, then was drained off and weighed at the end of the run. Steam produced but not used in the process could be directed by a three-way valve to a condenser where it was condensed and the condensate weighed, so it could be subtracted from the total steam generated during the run



How to Evaluate Interactions

Carlos A. Zapata

Chemical Engineer, Ansul Chemical Co., Marinette, Wis.

When two compounds, *A* and *B*, are mixed in a reaction system, there are various ways in which they can interact and we need a simple method of evaluating such interaction. There are three cases which can occur:

• Compounds *A* and *B* have similar effects and do not interfere with each other. This is the common effect.

• The effect of compound *A* is markedly increased by the simultaneous presence of compound *B*. This sort of interaction is called synergism.

• Or, compound *B* may tend to nullify some or all of the effect of compound *A*. A neutralization effect of this sort is called antagonism.

A simple statistical technique can be used to interpret these three cases graphically. For example, suppose that under well-controlled laboratory conditions we observe the effect of varying proportions of *A* and *B* on some response *X* of the system, e.g., the yield. We have five samples, each the result of averaging four observations to obtain the average response X_{av} and the range *R* (the largest value in the sample, minus the smallest value). These values are tabulated above and are also plotted on the charts.

Values Shown on Chart

Sample No.	Mixture % *A*	Mixture % *B*	X_{av}	Range *R*
1	10	90	9.5	1.2
2	25	75	8.2	1.8
3	50	50	8.4	1.1
4	75	25	10.4	1.6
5	90	10	8.5	1.3

Readers familiar with the simple construction of the control charts for X_{av} and *R* will be able readily to check the correctness of the central lines for X_{av} and R_{av} and for the position of the upper control limits (UCL) and lower control limits (LCL) shown on the graphs.

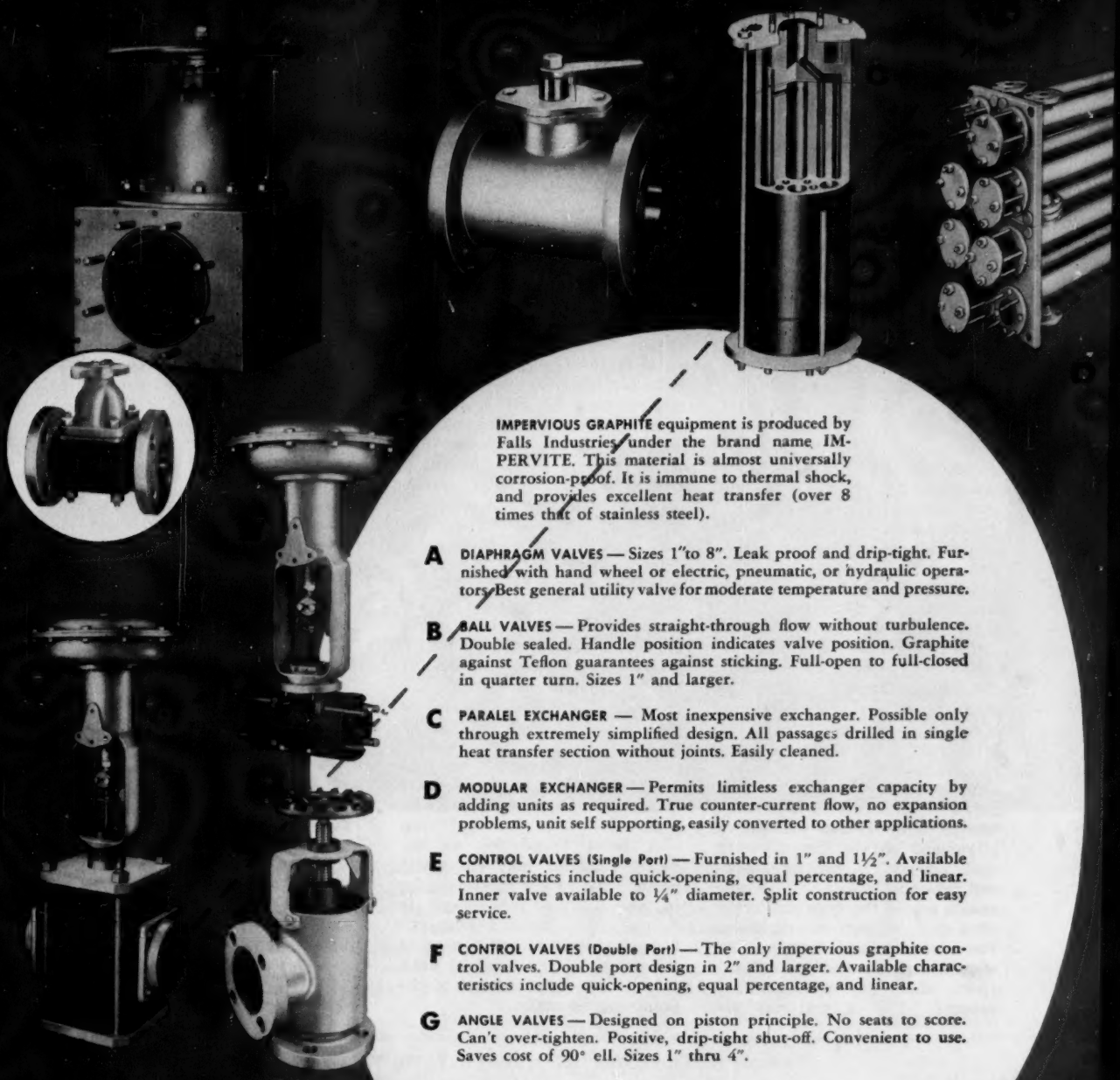
On the upper chart for response X_{av} we accept as evidence of synergistic action any point that falls outside the upper control limit. Conversely, a point falling below the lower control limit shows an antagonistic action. These criteria are justified, provided that the reaction system is under statistical control.

In the graphs, mixture No. 4 shows significant evidence (99.73% confidence level) of synergistic effect. However, all the other mixtures show nothing unusual in their behavior, putting them into the first group of effects mentioned above.

In the control chart for *R*, none of the points fall outside the upper control limit, so it is evident that the variability within the mixtures is under control.

(*Design Notebook Continued*)

. . . more new impervious graphite equipment from FALLS FI INDUSTRIES



IMPERVIOUS GRAPHITE equipment is produced by Falls Industries under the brand name IMPERVITE. This material is almost universally corrosion-proof. It is immune to thermal shock, and provides excellent heat transfer (over 8 times that of stainless steel).

A **DIAPHRAGM VALVES** — Sizes 1"to 8". Leak proof and drip-tight. Furnished with hand wheel or electric, pneumatic, or hydraulic operators. Best general utility valve for moderate temperature and pressure.

B **BALL VALVES** — Provides straight-through flow without turbulence. Double sealed. Handle position indicates valve position. Graphite against Teflon guarantees against sticking. Full-open to full-closed in quarter turn. Sizes 1" and larger.

C **PARALEL EXCHANGER** — Most inexpensive exchanger. Possible only through extremely simplified design. All passages drilled in single heat transfer section without joints. Easily cleaned.

D **MODULAR EXCHANGER** — Permits limitless exchanger capacity by adding units as required. True counter-current flow, no expansion problems, unit self supporting, easily converted to other applications.

E **CONTROL VALVES (Single Port)** — Furnished in 1" and 1½". Available characteristics include quick-opening, equal percentage, and linear. Inner valve available to ¼" diameter. Split construction for easy service.

F **CONTROL VALVES (Double Port)** — The only impervious graphite control valves. Double port design in 2" and larger. Available characteristics include quick-opening, equal percentage, and linear.

G **ANGLE VALVES** — Designed on piston principle. No seats to score. Can't over-tighten. Positive, drip-tight shut-off. Convenient to use. Saves cost of 90° ell. Sizes 1" thru 4".

DRAIN VALVES (not illustrated) — Designed expressly to eliminate possible clogging of drain outlets in tanks. Provides automatic clearing of outlets. Sizes 2", 3" and 4".

FALLS FI INDUSTRIES, INC.
AURORA ROAD — SOLON, OHIO
Phone: CHurchill 8-4343 — TWX: CV-720

Extending Data With Existing Charts

Herman F. Reinhold, Jr.

Hercules Powder Co., Parlin, N. J.

Process engineering calculations often require extending the data on the physical properties of a chemical compound or mixture beyond certain available values. For example, it may be necessary to find such values at a number of different temperatures. If the variation with temperature is linear, then there is no difficulty in making a linear interpolation or extrapolation. However, if the variation is logarithmic, then it may be convenient to use one of the existing alignment charts for physical properties, even though the chart does not cover the compound in question.

Some properties can often be assumed not to vary appreciably with temperature, for example, liquid specific gravity. Other properties, such as liquid thermal conductivities, may be assumed to have a linear variation with temperature. However, variations of liquid, vapor or gas viscosities cannot be handled so simply, since they are generally fitted better by a log-log plot of viscosity vs. absolute temperature.

An easy way to obtain a continuous set of viscosity values when you know the viscosity at only two temperatures is to make use of one of the well-known alignment charts for viscosity that appear in various standard reference works.[2, 4, 5, 8] These charts are of the type consisting of a pair of logarithmic scales for viscosity and temperature, with a separate pivot point between them for each material covered. For a material not covered, the pivot point can be found if two corresponding temperatures and viscosities are known. Simply draw the two lines on the chart, their intersection being the desired pivot point.

The method can be illustrated with dimethylaniline, a compound not covered in the existing viscosity charts nor in Seiner's recently published supplementary list of pivot points.[7] Experimental viscosity data[1] are given in the tabulation.

To see how close various estimation methods can come, assume that the viscosities at 10 and 40 C. are known, while those at 20 and 50 C. are required. Using the chart in Perry's Handbook,[5] we establish a pivot point with the intersection of the two lines for the known data, then determine the viscosities at 20 and 50 C. to be 1.41 and 0.89 cp. respectively. However, if we attempt to obtain the same values by linear interpolation or extrapolation, we get 1.47 and 0.82 as shown in the table. The comparison of methods illustrates that linear interpolation may be reasonably accurate if the temperature range is small, but that the use of the alignment chart is decidedly better for extrapolation.

A point found for an unlisted material may be worth keeping for future reference, for instance, as a supplement to Seiner's list.[7] If this is done, it's a good idea to record a note on the range of the original data, to be taken into account if the point is used again.

There are methods available for estimating viscosity data when sufficient or reliable experimental data are not at hand. Such reviews have been published by Gambill[2] and by Reid and Sherwood.[6] Such methods can be used to calculate two viscosities in the range desired for the process calculations, these then being used to find the pivot point for the alignment chart.

Existing alignment charts for other physical properties such as thermal conductivity of liquids or gases, or specific heat of gases, may be used similarly. This is often quicker than making frequent interpolations or a plot. It's also convenient for future reference. Incidently, in the case of thermal conductivity of liquids, separate charts are required, depending on whether the thermal conductivity increases or decreases with increasing temperature.

If the wrong chart is used the two temperature-conductivity lines will not intersect between the two scales of the chart. In the usual range of engineering calculations, thermal conductivity of water and of most aqueous solutions will generally increase with increasing temperature. The reverse is true for petroleum fractions and organic chemicals. However, the direction of variation will be obvious in any case from the data.

Comparison of Experimental and Estimated Viscosities

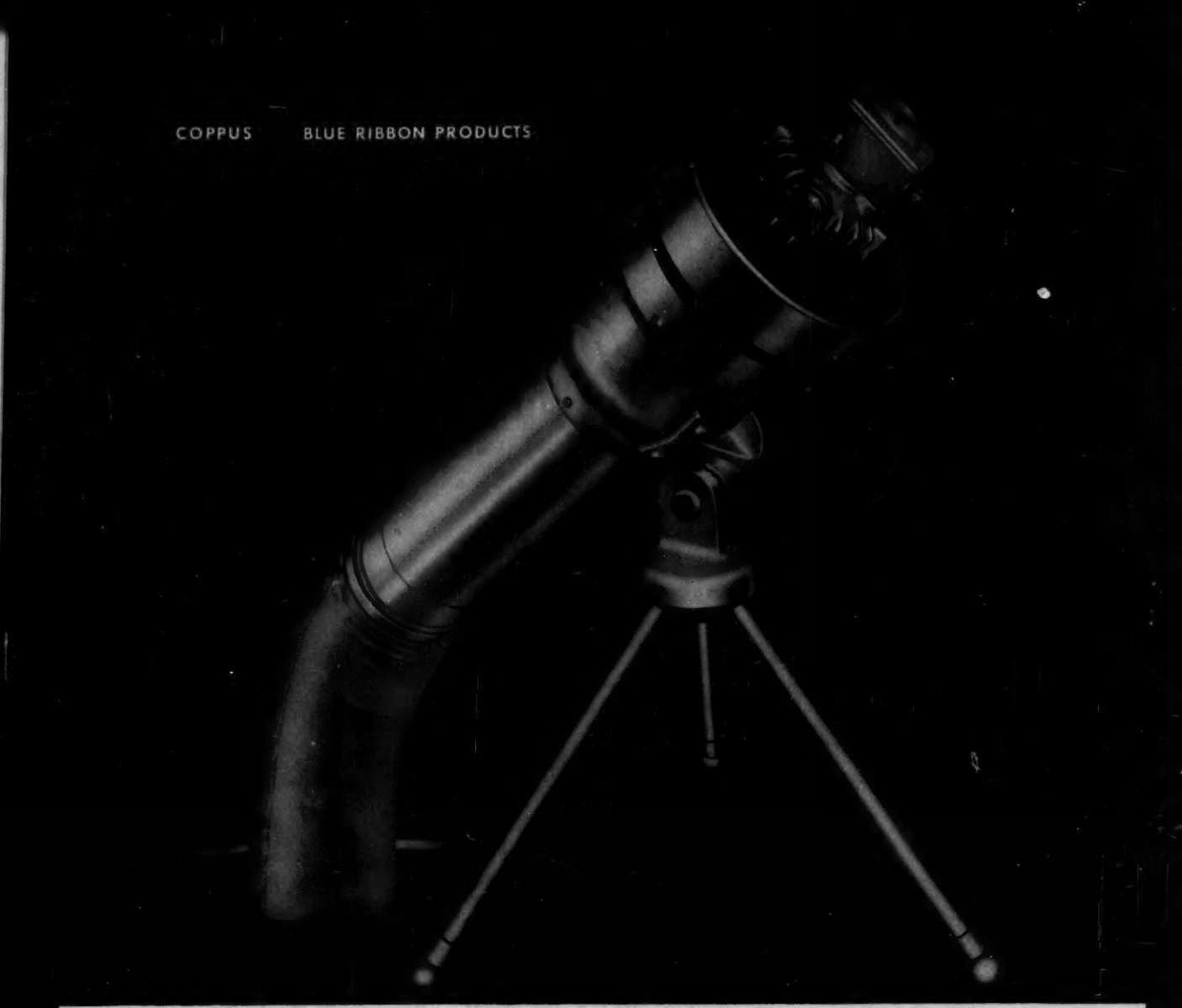
Temperature, Deg. C.	Viscosity, Cp. Experimental Data	Est. by Chart	Est. Linearly
10	1.69	.....	.....
20	1.41	1.41*	1.47*
40	1.04	.....	.....
50	0.91	0.89†	0.82†

* Est. by interpolation; † est. by extrapolation.

References

1. Hodgman, C. D. (ed), "Handbook of Chemistry and Physics," 40th Ed., p. 2159, Chemical Rubber Publ. Co., Cleveland. 1958.
2. Gambill, W. R., *Chem. Eng.*, issues of Sept. 22, Oct. 20 and Nov. 17, 1958; and Jan. 12, Feb. 9 and Mar. 9, 1959.
3. Kern, D. Q., "Process Heat Transfer," pp. 822-25. McGraw-Hill Book Co., Inc., New York. 1950.
4. McAdams, W. H., "Heat Transmission," 3rd Ed., pp. 466-9. McGraw-Hill Book Co., Inc., New York. 1954.
5. Perry, J. H. (ed), "Chemical Engineers' Handbook," 3rd Ed., pp. 370-3. McGraw-Hill Book Co., Inc., New York. 1950.
6. Reid, R. C., and T. K. Sherwood, "The Properties of Gases and Liquids," Chap. 6. McGraw-Hill Book Co., Inc., New York. 1958.
7. Seiner, J. A., *Chem. Eng.*, Sept. 22, 1958, p. 176.
8. "Standards of Tubular Exchanger Manufacturers Assn.," 3rd Ed., pp. 118-9. New York. 1952.

COPPUS BLUE RIBBON PRODUCTS



Coppus Vano® Ventilator

DON'T LET BAD AIR SLOW UP PRODUCTION!
Improve your men's efficiency, safety, health and comfort. Get rid of dangerous gases, fumes and stagnant air with a COPPUS "Blue Ribbon" Vano Ventilator. This ventilator brings fresh air to men in confined places . . . acts as both a safety device and a production tool. To keep your men's efficiency and morale high, feed them better air.

There's a portable, easily adaptable Coppus "Blue Ribbon" Ventilator to fit your specific "fresh-air" requirements. The Coppus "Blue Ribbon" is your assurance of sound workmanship and trouble-free, long lasting operation . . . at reasonable cost. Sales Offices in Thomas' Register. Other "Blue Ribbon" Products in Chemical Engineering Catalog, Refinery Catalog and Best's Safety Directory.

COPPUS ENGINEERING CORPORATION, 224 PARK AVENUE, WORCESTER 10, MASS.
Please send information to improve worker safety — health — comfort — efficiency

For Men Working:	For Cooling:	For Exhausting:
☐ in tanks, tank cars, drums, etc.	☐ general man cooling	☐ welding fumes
☐ in underground manholes	☐ motors, generators, switchboards	☐ noxious fumes
☐ on boiler repair jobs	☐ wires and sheets	☐ fumes from reactors, tanks, etc.
☐ in aeroplane fuselages, wings, etc.		

(Write here any special ventilating problems you may have)

.....

.....

Name.....

Company.....

Address.....

City.....

COPPUS BLOWERS

Instrument maintenance program helps . . .

Reduce Costly Down Time

H. M. Schenk, Research Dept., Stackpole Carbon Co., St. Marys, Pa.

In the last several decades, instrumentation has made phenomenal progress with more and more complex processes automatically controlled. Indeed, the expression "automatic factory" is used almost casually. Almost every new process set up is envisaged as a push-button operation with one or two operators standing by, twiddling their thumbs. All too often, however, the operators are idle because the process is shut down and swarming with maintenance men.

Like any other machine, instruments require maintenance and, like other machines, they can be over-maintained to the point where the cost of care outweighs the savings expected from their use. Our problem was to determine how we could maintain our instruments to prevent costly breakdowns and balance the cost of such a program against the anticipated savings.

When we started the study of our instrumentation about four years ago, we found that our instrument men spent 90% of their time on "fire extinguisher" emergency maintenance. A look at the cost of downtime in several departments gave quick proof that it would be worthwhile to spend some money on a preventive instrument maintenance program to reduce these costly shutdowns. For instance, our investigation showed that in one department an instrument failure that affected temperature control could cost as much as $2,000 if the trouble were not corrected within 15 minutes; further, it would cost $200/hr. after that until the trouble was corrected. In the same department, failure of an atmosphere control system could cost the same $2,000 within a very few minutes.

In other departments, certain batch furnaces contained loads worth up to $8,000. Failure of the controlling instrumentation could ruin the entire load. And these costs did not even take into account the idle man hours in the department while waiting for the process to go back on stream.

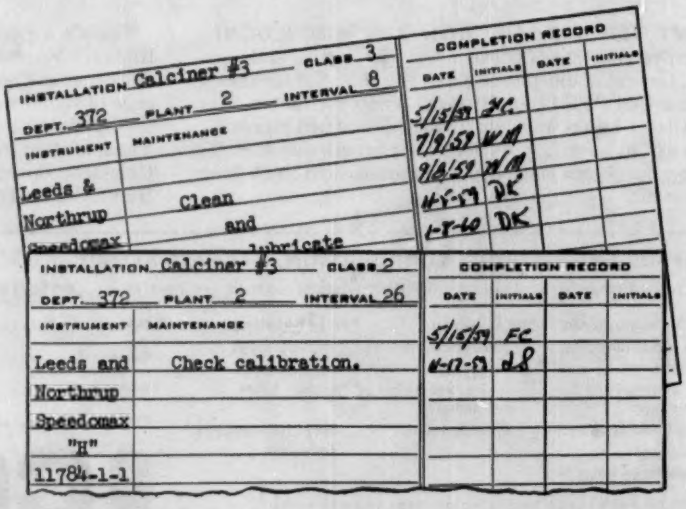
After much discussion and some trial and error, we put into effect an inspection, maintenance and training program which prevented most of the shutdowns, yet did not increase instrument department costs.

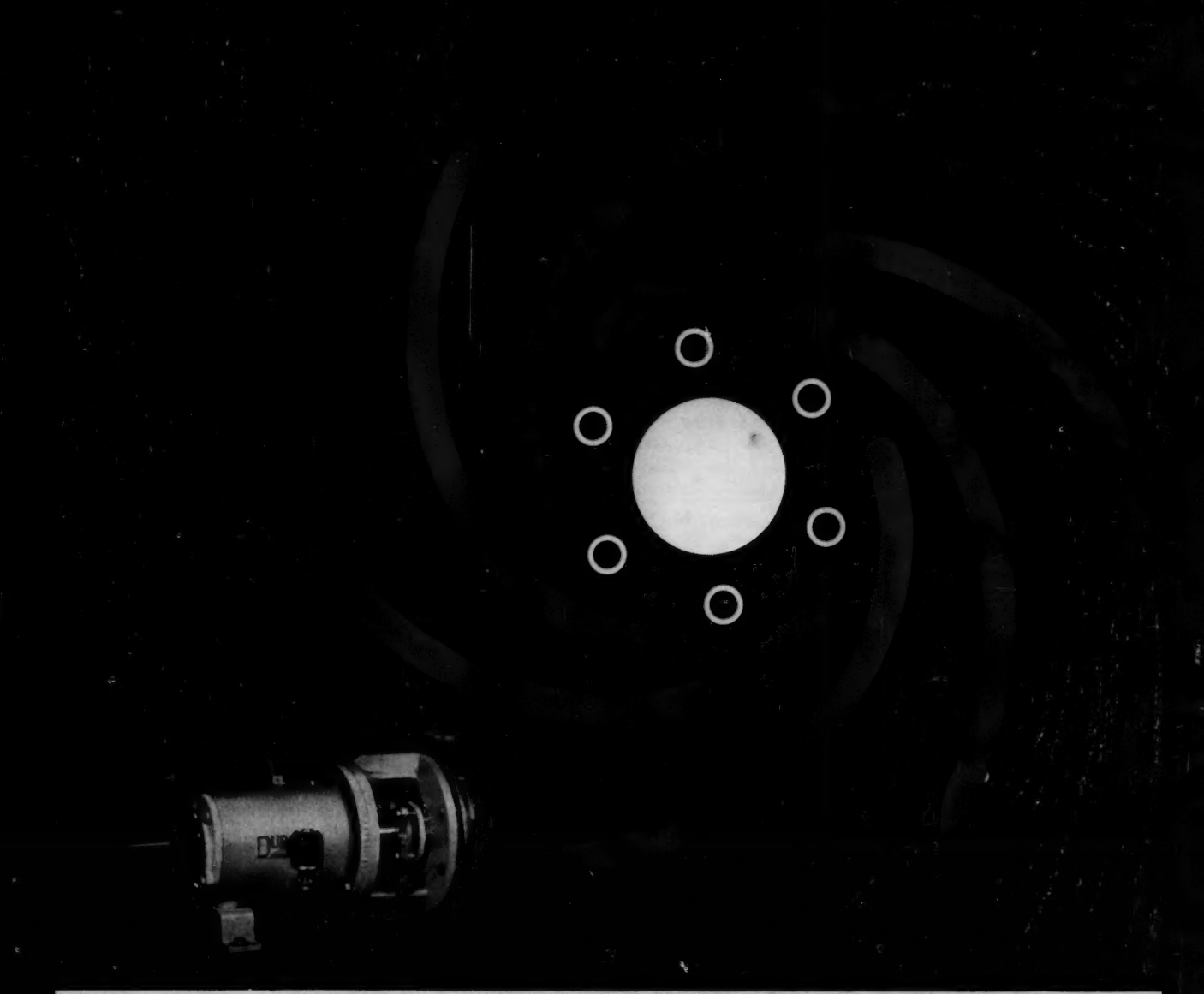
▶A Fair-Sized Company—Our company has about 3,000 employees and uses about 1,100 instruments. These instruments consist of over 300 recording potentiometers, such as the Leeds and Northrop "Speedomax," over half of which have control units associated with them. There are also about 150 on-off controllers of the milli-volt type, about 100 mechanical controllers of the mercury bulb or bimetallic strip type and about 350 panel mounted meters of the moving vane type. We have about 100 laboratory instruments ranging from simple potentiometers to complex spectrometers. The instrument shop is also responsible for associated primary elements such as thermocouples, rayotubes, etc.

Our system is basically one of training, inspection, maintenance, record keeping and cost accounting with emphasis on those areas where failure is most costly.

▶Training—We started our training program four years ago with regular classroom instruction. Our men spent several hours per week on this classroom training, taking time from

Cards for Each Instrument Keep Program on Track—Fig. 1





Specific design for pumping corrosives

Here is the first pump designed specifically for long life in heavy duty corrosive service.

Durcopumps are made in fourteen standard alloys and special materials. Four bearing housings plus separate frame adapters give maximum interchangeability for all pump sizes.

Maintenance is short and sweet because the working parts can be removed as a unit—in minutes—serviced and reinstalled by a single trade. Pump casing, piping and motor are not disturbed.

Durcopumps are produced in standard, self-priming and vertical submerged designs. Pumps are available with heads to 345 ft., capacities to 3500 gpm, in sizes from 1" x 1" to 10" x 8". Standard operating temperatures to 500° F.

Call your nearest Durco Service Engineer or write for literature on your service application.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON COMPANY, INC., Dayton, Ohio / Pumps • Valves • Filters • Process Equipment

Permanent Record Card Pinpoints Recurrent Troubles—Fig. 2

Form 8-344 2M 10-57 Daily Press

INSTRUMENT RECORD

MODEL 2-01-041-014-6-24 SERIAL 11784-1-1 CARD #1

RANGE 0-2200°F C A KIND Speedomax "H"

MAKE Leeds & Northrup LOCATION Plant 2

Dept. 372 - Calciner #3

DATE	REMARKS	BY
4-30-59	Received new from Mfr.	P.
5-7-59	Installed in panel, wired	J.S.
5-15-59	Instl. battery, pen, cleaned & lubricated checked calibration, Calciner started	F.C.

every thing except real emergency work. Each man spent several additional hours per week in on-the-job training. We started the program during the summer and the employment of summer workers was a big help.

Once out of the woods, we were able to set up a training program that takes very little time from regular work. When a new man enters the department it is with the understanding that he will enroll in a correspondence course in Industrial Instrumentation for which the company will pay upon successful completion. Successful completion of the course is a requirement for staying in the department, and, thus far, all our men have successfully completed it. Though the course is not tailor-made to our needs, it nevertheless covers most of the principles of instrumentation at a respectable level.

We encouraged several men to take a year's course in physics from the Extension Branch of the Pennsylvania State University. We also use the manufacturers' schools and have been trying to send at least one of our five instrument men to one of these schools each year. We find manufacturers' schools most helpful if the man attends after a minimum of one year on the job. The company, of course, pays for all schooling upon successful completion.

We encourage new equipment demonstrations in our shop for all instrument men. Installation of new type instrumentation also calls for on the spot instruction of all personnel. Periodicals and manufacturers' publications are routed to the instrument men to keep them up to date.

▶ **Three Classifications**—All our instrument work is divided into three classes, Class 3 being the simplest. We feel that any man coming into our department should be able to handle most of the jobs in the Class 3 category with one or two months of on the job training, this training usually being under a more experienced man with occasional personal supervision by the supervisor.

Class 2 work covers almost all other instrument maintenance including calibration and complete checking out of an instrument for performance as per specifications. Our experience so far has shown that it takes from 1½ to 2 yr. for a man to be fully qualified for Class 2 work.

Class 1 includes all the above plus installation, supervision of other instrument men, trouble shooting and work on the most complex instruments. We have not been operating this system long enough to reach any conclusion as to how long it should take a man to be classified as Class 1. In fact, it seems that no time limit can be placed on this since it is a very individual thing requiring a type of person who wants and can assume the responsibility that goes with trouble shooting, installation and supervision.

▶ **Inspection**—We inspect about 300 critical instruments every day, almost all of them recording potentiometers and their control units. This daily inspection is our so-called "chart run" and is done by Class 2 instrument men. On his daily run, the instrument man inspects and services these instruments, makes chart changes, replenishes ink supplies, replaces batteries as required and so on. His principal duty, however, is visual inspection of the unit for satisfactory operation. He sees that the tubes are lighted and the amplifier operating. He can determine that the process is being controlled at the control point and inspection of the record should show him any lack of sensitivity or other erratic behavior.

In addition, a man comes in on weekends or holidays to inspect instruments operating through these holiday periods.

The only record kept of this work is the name of the individual responsible for daily inspection over a given period of time. Any work done other than chart and ink replacement, however, is noted on the permanent record card for the instrument.

This daily inspection is an important part of our system. We make it clear to our men that by their return to the shop after the daily "chart run," they signify that all instruments on their route have been serviced, inspected and are operating satisfactorily.

▶ **Maintenance**—We schedule preventive maintenance with the cards shown in Fig. 1. Information on the card includes the location of the instrument—in this case Calciner No. 3 in Dept. 372 of Plant 2—, the classification of the instrument man who should do the work, the interval in weeks at which the work should be performed, identification of the instrument and the work to be done. There is also space for the date of completion of the work and the initials of the man who did it.

The work and the interval at which it is to be done are always that recommended by the manufacturer on a new type of instrument. The intervals and the actual work done are sometimes changed later to suit the particular installation.

Note that we use two cards for

CARBORUNDUM'S TECHNICAL INFORMATION ON UNUSUAL REFRACTORIES

Data sheet

How to choose materials for

WEAR RESISTANCE

Choice of a material to give optimum wear resistance requires knowledge of type of wear (e.g. abrasion or erosion), effect on different materials, and presence of such factors as load, corrosion, thermal shock etc.

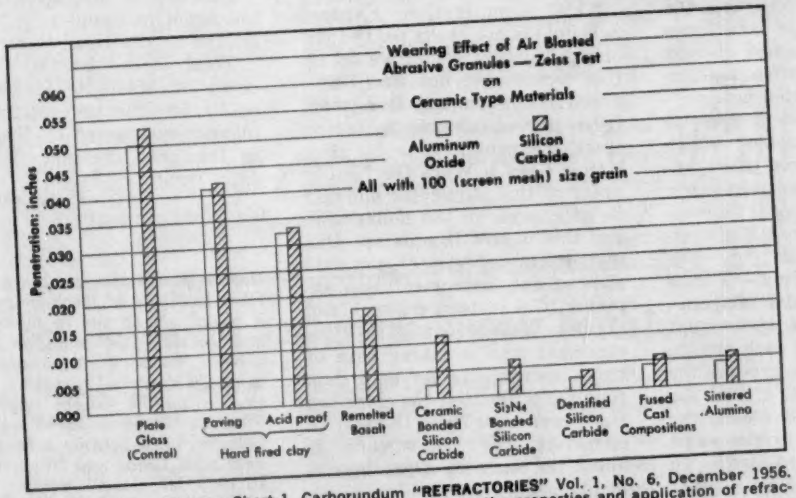
The two basic types of wear (examples shown at right) are (1) impingement of fine solids entrained in air, gas, or other fluid and (2) direct sliding of a solid mass across a surface. Effects may be erosion, primarily of the bond, thus dislodging the harder body granules; minute progressive bond fracture due to impact; or chipping, gouging or grinding of monolithic materials.

Refractories manufactured by Carborundum from electric furnace materials — such as silicon carbide and alumina — offer excellent wear resistance (see chart). Moreover, they are chemically inert, resistant to spalling, and have superior load-carrying capacity. As a result, they have found extensive use in dust collectors, gas scrubbers, transfer pipelines, hydro-cyclones, etc.

Carborundum's accumulated experience and data may help solve your wear problems. Feel free to ask for any assistance.

Abrasion by more than 2,500,000 pounds of sinter dust in 7 years has been resisted by the CARBOFRAX® silicon carbide lined cone of this primary dust collector. By comparison, other brick in the scroll and in the course between scroll and cone have been worn back to the shell, in one area after only 5 months.

Skids of CARBOFRAX® silicon carbide lasted 156 weeks under heat and the abrasion of 6¾" x 8" brass billets in this gas-fired extrusion mill furnace. Steel skids averaged only 5 weeks life.



Write today for your free copy of "Super Refractories by Carborundum." The address: Dept. H-40, Refractories Div., Perth Amboy, N. J.

Information adapted from Chart 1, Carborundum **"REFRACTORIES"** Vol. 1, No. 6, December 1956. This bulletin, containing extensive technical information on the properties and application of refractory-type products, is published bi-monthly. Complimentary subscription on request.

For engineered refractories, count on **CARBORUNDUM®**

Comparative Expense Schedule Itemizes Expenses, Shows Where the Money Goes—Fig. 3

STACKPOLE CARBON COMPANY
COMPARATIVE EXPENSE SCHEDULE

MONTH ENDING

DESCRIPTION	DEPT.	CHARGE	CURRENT MONTH	THIS YEAR TO DATE	LAST YEAR TO DATE
INSTRUMENT DEPARTMENT					
*Scheduling	926	03			
*Purchasing and Stores	926	06			
Specialized Personnel	926	08			
Labor Fringe Cost	926	07			
Supplies	926	60			

this particular type of instrument covering two levels of preventive maintenance. Some instruments require only one card while others require three. When this card is signed off and returned to the instrument shop, a notation of the work done as recorded by this card and any additional work done at the time are entered in the permanent record card, Fig. 2. The preventive maintenance scheduling card (Fig. 1) then goes into a "poke file" the proper number of weeks ahead.

▶**Records**—In addition to the preventive maintenance card in the poke file, we keep a permanent record card for each instrument. Fig. 2 shows one of these cards, one of which is kept for each amplifier. Note that the extra work which is sometimes spotted and performed during the routine preventive maintenance visit is recorded here.

These cards make it easy to spot recurring troubles which usually indicate some other unknown trouble or faulty practice. They have also helped us compare maintenance costs for various instrument types.

▶**Cost Accounting**—Fig. 3 shows a Comparative Expense Schedule which the instrument department receives each month. The sheet shows the expense for the month just past, a total for the year to date and a total for the previous year to the same date. Items marked with an asterisk are charged on a plant wide basis—total expenses are proportioned to all departments throughout the plant.

Other items can be defined as follows: "specialized personnel" is a charge to the instrument department for outside personnel other than service department labor. "Labor fringe cost" is a charge against the department calculated by multiplying the number of instrument personnel man hours by the cost per hour of company fringe benefits. "Supplies" refers to expendable items consumed by the department. The "stores" account covers those things which the instrument department purchased and put into stock for use throughout the plant.

"Service labor" refers to charges made by service departments for work done for the instrument department.

This Comparative Expense Schedule is not really part of the original program that we set up four years ago, but was introduced by the company since then. It has proved valuable in keeping track of expenses.

▶**How Does It Work Out?**—The proof of this particular pudding is, of course, in the dollar sign and this is how it adds up. Our instrument department now consists of one instrumentation engineer, five instrument men and a clerk. This group of five instrument men is taking care of more instruments per man than four years ago, but the clerk has since been added and the cost of operating the department is about the same on a per instrument basis.

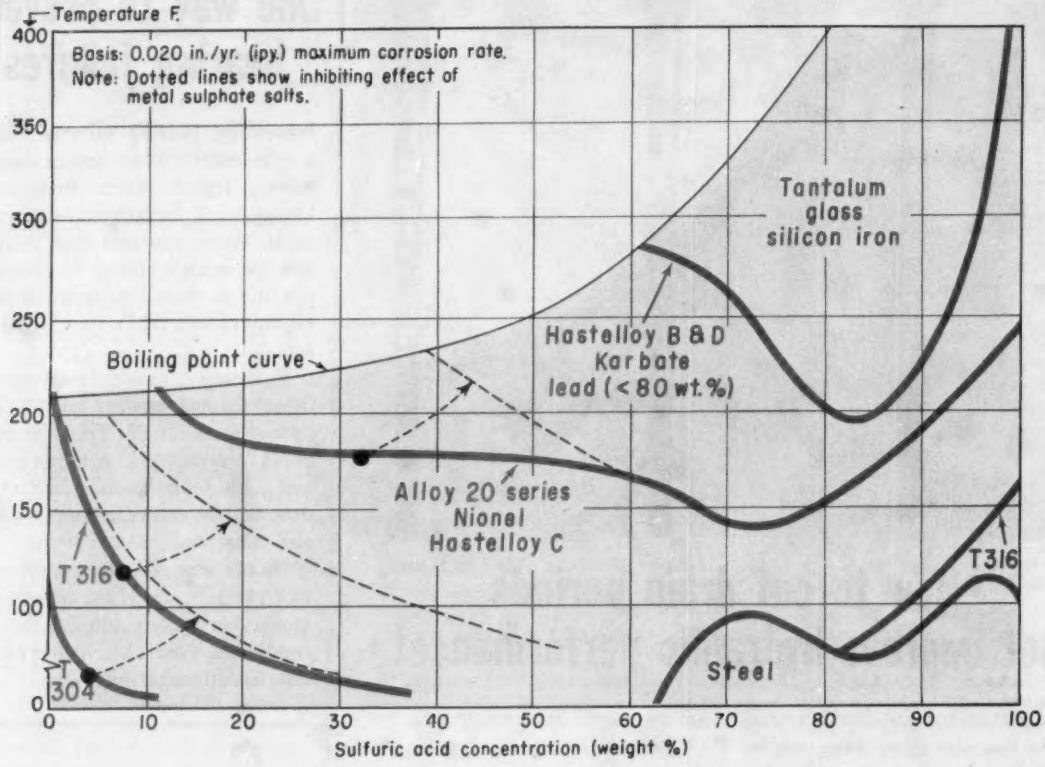
The really significant savings come from the elimination of the previously high percentage of "fire extinguisher" emergency work with the resultant high costs of lost production. We now average less than 10% of our time on emergency calls, versus the previous 90%, and some of these calls prove to be no fault of the instrument concerned.

How much would this system cost in your plant? You can figure about 20 man hours per year for each recording potentiometer with an additional 5 man hours for an associated control unit. Millivolt meters require about 10 man hours and simple mechanical controllers and panel mounted meters take about 1 man hour each for once or twice a year on the spot calibration checks.

Laboratory instruments vary too much in complexity to generalize on the time required.

Total time can be broken down into about 10% for emergencies, 50% for preventive maintenance as covered by the cards in the poke file and 40% for daily inspections.

HARRY M. SCHENK graduated from Case Institute of Technology with a bachelor's degree in mechanical engineering, then went on to receive a master's in physics from Western Reserve University. After graduation, he taught physics at Western Reserve for five years then, in 1951, became a field engineer with Leeds and Northrup Co. In 1955, Mr. Schenk became an instrumentation engineer with Stackpole Carbon Co., his present employer. Mr. Schenk is a member of the AIEE.



New Look at Sulfuric-Resisting Alloys

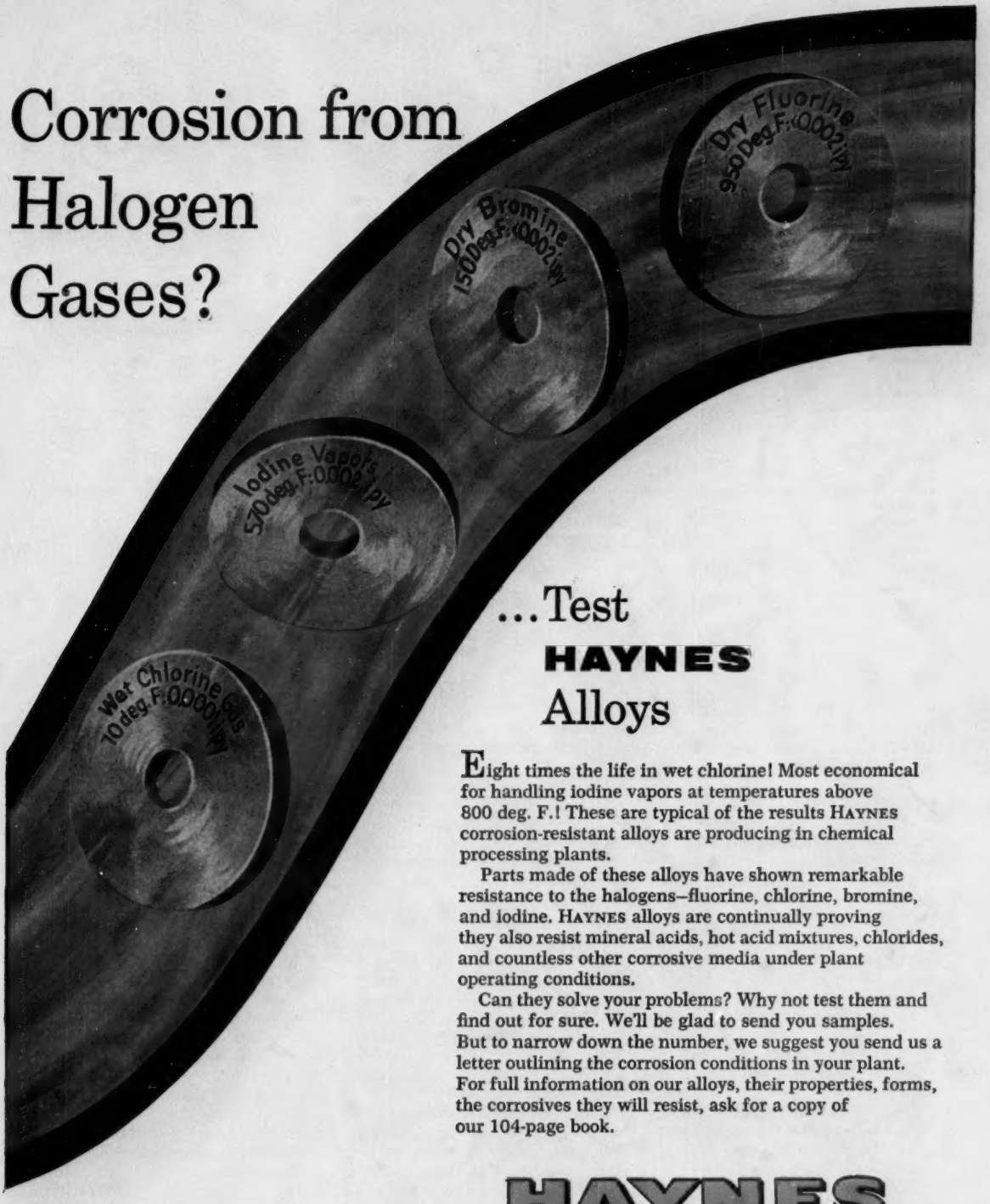
"At-a-glance" corrosion chart for sulfuric acid is based on an extensive survey of construction materials; gives rough indication of suitable alloys.

C. M. Schillmoller, West Coast Field Section, International Nickel Co., Los Angeles, Calif.
F. L. LaQue, Vice President, Mgr., Dev. and Research Div., International Nickel Co., New York, N. Y.

A variety of methods have been proposed and many are used for the presentation of corrosion data in concise form. The authors are basically opposed to the presentation of information in simplified chart form if this material alone is to be used for the selection of the proper alloy of construction.

Corrosion is very complex and its vagaries are numerous. Seemingly unimportant variables such as small amounts of impurities can change the corrosion picture completely. However, concise and condensed information is valuable in that it

Corrosion from Halogen Gases?



...Test HAYNES Alloys

Eight times the life in wet chlorine! Most economical for handling iodine vapors at temperatures above 800 deg. F.! These are typical of the results HAYNES corrosion-resistant alloys are producing in chemical processing plants.

Parts made of these alloys have shown remarkable resistance to the halogens–fluorine, chlorine, bromine, and iodine. HAYNES alloys are continually proving they also resist mineral acids, hot acid mixtures, chlorides, and countless other corrosive media under plant operating conditions.

Can they solve your problems? Why not test them and find out for sure. We'll be glad to send you samples. But to narrow down the number, we suggest you send us a letter outlining the corrosion conditions in your plant. For full information on our alloys, their properties, forms, the corrosives they will resist, ask for a copy of our 104-page book.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of
Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

The terms "Haynes" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Popular Metals and Alloys Used in Sulfuric Acid Service (% Composition)

Name	Chromium	Nickel	Molybdenum	Copper	Iron	Carbon	Other Principal Elements
Lead	—	—	—	—	—	—	
Cast irons	—	—	—	—	—	—	
Stainless steel 316	18	12	2.5	—	Bal.	0.07	
Copper	—	—	—	99.9	—	—	
Silicon bronze	—	—	—	96.0	—	—	Silicon 3, Mn, Sn, Zn
Monel	—	67	—	30	1.4	—	Manganese 1
Ni-o-nel	21	42	3	2	Balance	0.05	Titanium stabilized
Labour R55	23	52	4	4	Balance	—	
Illium G	21	60	6	4	6	—	
Hastelloy F	22	48	6.5	—	15	0.03	
Hastelloy C	16	54	16	—	5	0.05	Tungsten 4.0
Hastelloy B	1	61	28	—	5	0.03	Silicon 1.0
Hastelloy D	—	82	—	3	1	0.10	Silicon 9
Chlorimet 2	—	63	32	—	2	0.10	
Chlorimet 3	18	60	18	—	2	0.07	
Duriron	—	—	—	—	Balance	0.8	Silicon 14.5
Corrosiron	—	—	—	—	Balance	0.8	Silicon 14.5
Tantalum	—	—	—	—	—	—	
Titanium	—	—	—	—	—	—	
Worthite	20	25	3	1.75	Balance	0.07	Silicon 3.5
Elcomet	20	26	3	2	Balance	0.07	
Aloyco 20	20	29	1.75	3.5	Balance	0.07	
Durimet 20	20	29	1.75	3.5	Balance	0.07	
Carpenter 20	20	29	3	4	Balance	0.07	

presents a bird's-eye view of the situation and can be used for screening purposes, thus minimizing the number of materials to be tested or considered.

► **Condensed Data** — The question is how far can one go in condensing information and still have it be of substantial value? The chart (p. 170) is an attempt to condense corrosion data so that the general picture can be obtained "at a glance." A tremendous amount of data has been used as the basis of this seemingly simple graph.

Curves drawn are iso-corrosion lines for 0.020 in./yr. corrosion rates—which are, in most cases, the economic limit of alloy selection.

The chart summarizes limits of usefulness for the more common construction materials in sulfuric acid solutions.

Regions of operating conditions are indicated in which corrosivity is controlled by sulfuric-acid temperature and concentration and the alloys most suited economically are shown in this region.

Of course, alloys capable of handling more aggressive operating conditions can also be chosen if first cost, mechanical or other reasons require this, such as, for example, lead instead of Type 316, silicon-iron heating tubes instead of Hastelloy D in acid concentrators or Alloy 20 impellers to pump warm solutions which ordinarily can be handled by Type 316 stainless steel when velocity effects play no part.

► **Shows Inhibitors** — Also, the inhibiting effect of metal sulfate salts is shown. This phenomenon substantially extends the useful range of nickel stainless steels.

Dotted lines indicate the average extension of the regions for Type 304, Type 316 and the Alloy 20 series. This extension is very conservatively shown for copper electrolyte solutions when the copper is in the cupric sulfate form; similarly, oxidizing nickel and cobalt solutions may contain enough ferric and cupric sulfates to substantially extend passivity and allow 304, 316 to be employed. This assumes, naturally, that no chlorides interfere with passivity.

Of course, the chart should only be used as a rough guide. And a few comments on the various materials shown on the curves and in the table above are necessary to get a proper perspective. The following discussion is aimed principally at the metal extraction and refining industry, but can be just as useful in any sulfuric-acid-using process.

► **Old Standbys**—Cast iron and carbon steel are widely used for handling sulfuric acid in concentrations over 70% at ambient temperatures.

Chemical lead (0.06% Cu) is the famous old standby in sulfuric acid plant construction and its merits have gained wide recognition. It resists sulfuric acid very well, except for the strong acids (over 80%) at elevated temperatures.

Lead, cast iron and carbon steel all depend for their corrosion resistance on a protective sulfate film. Solubility of these films depends on temperature and concentration of the sulfuric acid. The films can also be readily destroyed by velocity and impingement conditions, making such materials unsatisfactory for valves, pumps, and often elbows and nozzles.

► **Stainless Steels**—The 400 stainless steels are not resistant

to sulfuric acid environments and the minimum stainless steels we can consider are the 300 series or so-called 18-8 austenitic stainless steels.

Types 304, 321 and 347 can normally be used only in very dilute sulfuric acid applications at room temperature, and show equally good resistance to corrosion. Type 316 has much better resistance to dilute sulfuric and can be used in a broader range of temperatures and concentrations.

Corrosion rates decrease for stainless at high acid concentrations (over 80%).

Where welding is involved, the low-carbon materials (0.03% maximum carbon) or the stabilized stainless steels are the correct alloy selection to avoid intergranular corrosion. Generally speaking, Type 316L is the preferred and necessary selection for the majority of electrolyte handling equipment.

The Alloy 20 materials are good for velocity conditions and are particularly resistant to solutions containing oxidizing salts, such as ferric and cupric sulfates. Limiting concentrations and temperatures will be extended by the addition of such oxidizing salts to sulfuric acid solutions.

▶ **Copper, High Nickel**—Copper, silicon bronze and Monel (nickel-copper) find very wide use in chemical processes involving sulfuric acid under air-free and essentially reducing conditions at moderate velocities. These alloys are employed in concentrations generally below 60% sulfuric acid and up to 200 F. Monel especially provides excellent service under these conditions and is commonly used in pickling operations and sulfonation.

In air-saturated sulfuric or in the presence of oxidizing cupric and ferric salts, the corrosion rate will increase considerably for this group.

Ni-o-nel, Labour R55, Illium G, Hastelloy alloys C and F cover somewhat the same fields of application as the Alloy 20 series—the additional alloy content ensures passivity under more aggressive conditions caused by velocity or temperature. See *Chem. Eng.*, Dec. 14, 1959, p. 194, for data on a new Illium alloy.

Hastelloys B and D were developed for handling sulfuric acid under very severe conditions, and they find use particularly in acid evaporators where dilute sulfuric is concentrated to about 65%. Alloy B is more resistant to boiling sulfuric up to about 60%, while D is employed chiefly over 60% concentration.

Hastelloy alloy B, however, is not recommended for sulfuric solutions containing strong oxidizing agents.

Chlorimets 2 and 3 are widely used in pumps and valves. Chlorimet 2 is preferred under reducing conditions, while Chlorimet 3 performs especially well when oxidizing salts are present in the sulfuric acid solution at moderate temperatures (Behavior of Chlorimet 3 and that of Hastelloy alloy C are comparable).

▶ **High Silicon**—The high-silicon irons, such as Duriron and Corrosiron exhibit excellent resistance to all concentrations of sulfuric acid up to and including boiling temperatures. They are available in cast form only.

Silicon irons are hard and difficult to machine and are very susceptible to thermal and mechanical shock. These are the chief limitations of this alloy, offsetting in many applications their first-cost price advantage.

▶ **Tantalum, Titanium**—Tantalum equipment has been used safely with sulfuric acid under a wide variety of conditions without loss or damage due to corrosion. The material gives good performance under reducing as well as under oxidizing conditions. Its price structure, however, limits use to special applications, such as bayonet heaters and liners of steel equipment handling boiling sulfuric acid (concentration by evaporation).

Titanium is chiefly known for its excellent corrosion resistance to a wide variety of oxidizing chemicals, such as nitric acid. It resists sulfuric in the presence of oxidizing salts, such as cupric and ferric sulfates.

Titanium resistance normally breaks down in a reducing system. In a recent development, titanium has been alloyed with a fractional percentage of platinum or palladium which markedly improve its corrosion resistance to reducing acids without impairing resistance under oxidizing conditions.

▶ **Karbate, Glass**—Karbate and impervious carbon and graphite are suitable for sulfuric acid concentrations from 0 to 90% and process temperatures up to 340 F. These materials have high thermal conductivity and are practically immune to thermal shock.

Their chief limitation is low mechanical strength. Careful handling is required.

Glass has excellent resistance to sulfuric acid under reducing as well as under oxidizing conditions, and can be used under all conditions of temperature and concentration. In commercial applications, it is used either in glass form for transfer lines, etc., or in glass-lined steel equipment.

The chief limitation, of course, is its mechanical properties. Glass equipment can be easily damaged by mechanical and thermal shock which makes its reliability and justification often questionable.

▶ **Plastics, Rubber**—Last, but not least, are the plastic and rubber materials.

Plastics in general have good corrosion resistance against dilute solutions, are easy to install and have good electrical insulating properties. However they have relatively low temperature limitations, high thermal rates of expansion and can be subject to "weathering effects."

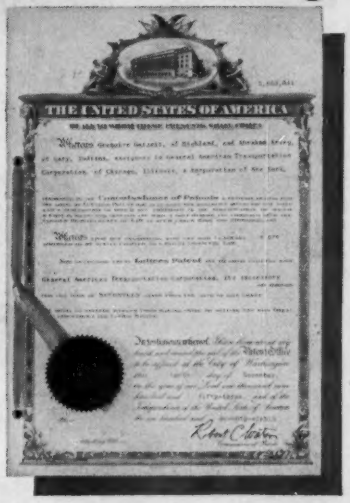
Soft or semi-hard rubber linings handling 50% sulfuric at room temperatures, and neoprene handling 70% at 120 F., are quite popular in sulfuric service.

As for coatings, baked-phenolic and coal-tar materials are usually recommended because of good resistance to sulfuric corrosion, abrasion and erosion. However, pinholes or cracks can result in extensive damage—most coatings are used on the outside of equipment and structures (noncritical areas) for this reason.

Condensed and extracted from a paper on materials of construction for use with electrolyte solutions encountered in extracting copper, nickel and cobalt: "Factors in the Choice of Corrosion-Resisting Materials of Construction," given at the annual meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers, N. Y. C., Feb. 15-18, 1960.

a Reminder

to those who use chemical nickel alloy plating:



There is only ONE Kanigen®

and 29 patents prove it

There are no substitutes for Kanigen—no other process that applies a hard, corrosion-resistant nickel alloy coating without the use of electricity as Kanigen does.

With Kanigen, you can plate anything from a small relief valve to a 20,000 gallon tank car with a virtually non-porous, uniform coating.

How can you be sure of getting Kanigen? Only one way—by calling General American or one of its licensees. For further information write:

Kanigen Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street
Chicago 3, Illinois
Offices in principal cities

KANIGEN GENERAL AMERICAN

LICENSEES

INDUSTRIAL KANIGEN CORPORATION
1421 Park Avenue
Emeryville, California

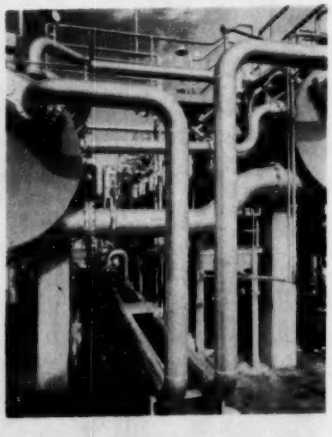
KEYSTONE CHROMIUM CORPORATION
1095 Niagara Street
Buffalo, New York

KEYSTONE METAL FINISHERS, INC.
22 Raydol Avenue
Secaucus, New Jersey

(*Continued from page* 76.)

ous ammonia, chlorine, caustic and vinyl chloride capacity to start up late in 1961 and early in 1962. Current $12-million expansion program, including a high-pressure polyethylene plant, is scheduled for operation this fall.

Foote Mineral Co. has just completed a major expansion of its electrolytic-manganese plant at Knoxville, Tenn. Foote's route to high-purity manganese resembles that of Union Carbide Metals Co. (*Chem. Eng.*, May 19, 1958, pp. 136-139).



Cleaver-Brooks Special Products, Waukesha, Wis., has just completed installation of the first sea-water conversion plant on the U. S.'s Pacific coast. Plant, built for Southern California Edison Co. on Mandalay Beach near Oxnard, Calif., extracts 100,000 gal./day of potable water from the sea by flash evaporation. Maze of pipe and tubing links 26 flash evaporation stages, that cost Edison more than $250,000.

J. M. Huber Corp. plans a $2.5-million expansion of its Baytown, Tex., carbon-black plant. Huber will thus double its present 25,000-ton/yr. output to satisfy rising demands by rubber and ink industries.

Collier Carbon and Chemical Co. discloses plans for construc-

tion of a sulfuric acid plant near Wilmington, Calif. Present construction schedule calls for completion by the end of the year. New plant output will go to Filtrol Corp., Vernon, Calif., which will produce ammonium sulfate.

Chase Bag Co. installs this $80,000 head box on a Fourdrinier paper machine at its Chagrin Falls, Ohio, paper mill. Installation is part of modernization program to increase plant efficiency and output; new head box ups Fourdrinier speed by 15%.

Bay Petroleum Co., a div. of Tennessee Gas Transmission Co., plans to break into the petrochemical field with construction of a 2,000-bbl./day aromatics unit at its Chalmette, La., refinery. Modernization of existing refinery is preceding the entry into petrochemicals: installation of a 35,000-bbl./day crude unit, a 2,700 bbl./day alkylation unit and revamping of catalytic cracking unit are nearly complete.

Westvaco, a div. of Food Machinery & Chemical Corp., plans addition of a $2-million phosphate-ore calciner to its Pocatello, Idaho, phosphorus complex. By calcining phosphatic shale feed, Westvaco plans to burn away carbonaceous content and thus upgrade phosphate content.

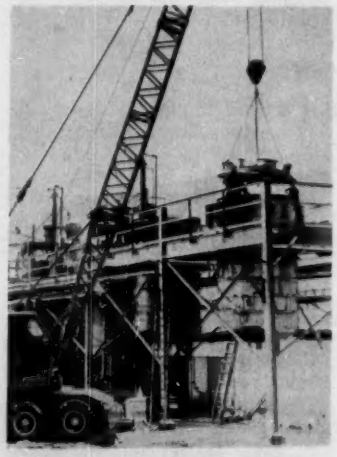
Carbide Chemicals Co., a div. of Union Carbide of Canada, Ltd., is negotiating contracts to double its ethylene oxide capacity at Montreal, Que. Pres-

ent construction schedule calls for completion by early 1961.

M. W. Kellogg Co. has begun construction of new, $4-million pipe manufacturing facilities at Williamsport, Pa. Adjacent metallurgical and welding laboratories will support the new facility.

Arizona Chemical Co. is upping tall-oil distillation and rosin-treating capacity at its Springhill, La., plant. Construction contractor, Badger Manufacturing Co., is shooting for a summer completion date.

American Smelting and Refining Co. has awarded Western Knapp Engineering Co., San Francisco, Calif., a contract to construct its 15,000 ton/day copper concentrator at Tucson, Ariz. Flotation concentrator, to cost $17-million, is part of American Smelting's $40-million Mission Project.



Alco Oil & Chemical Corp. puts the last wraps on a 30% expansion of its gum-product plant at Philadelphia, Pa. Crane lowers head onto top of reaction vessel, which is used to produce one of Alco's five gum products.

Bestwall Gypsum Co. is sinking a new mining shaft into its Blue Rapids, Kan., gypsum mine. New high-purity gypsum output will go to Bestwall's new specialty-products plant at Blue Rapids.

Anglo Southern Paper Corp. announces plans for a $60-million pulp and paper mill at Texarkana, Tex. Anglo officials are presently acquiring plant-construction site.

High Voltage Engineering Corp. readies itself for accelerating demand for accelerators, plans a 50% expansion of its Burlington, Mass., plant. With new capacity, High Voltage will fill its $9-million backlog of orders for accelerators and nuclear analyzing magnets.

Naugatuck Chemical Division of United States Rubber Co. ups its research capabilities with construction of a new technical center at Naugatuck, Conn. New halls will soon be buzzing with technical service, research, process and product development activities.

American Brass Co. broke ground for a $1.5-million research center at Waterbury, Conn. New laboratory will house expanded product development and technical service staffs.

Food Machinery & Chemical Corp. has just dropped Westvaco from the names of its Chlor-Alkali and Minerals Products Divisions; both will be known as FMC divisions.

Vitro Chemical Co., consolidates some of its operations by transferring inorganic chemicals production from Canonsburg, Pa., to its central, Chattanooga, Tenn., plant. Uranium-ore concentrating operations will remain at Salt Lake City, Utah.

Ebasco Services, Inc. strengthens its Management Consulting Division by acquiring H. Ferris White & Associates of Chicago, Ill. White special-

INDUSTRY NEWS . . .

izes in the field of industrial engineering.

Catalin Corp. of America joins forces with Dow Chemical Co., by signing a cooperative agreement covering synthesis and testing of new chemicals. Catalin will supply Dow with chemicals for testing purposes and Dow will supply Catalin with testing data.

CompuDyne Corp., manufacturers of computer-operated controls systems and components, has acquired electronic probe producer, Jarco Services, Inc., Tulsa, Okla. CompuDyne thus increases its facility to develop control systems for missile, nuclear and process industries.

Alaska Lumber & Pulp Co. has begun operating its new, 340-ton pulp mill at Sitka, Alaska. ALP vice president, Sakae Fukuyama, representing Japanese owner interests stands with mill manager, T. R. Stein, in front of a product roll. Howard S. Wright Construction Co., Seattle, Wash., and Guy F. Atkinson Co., San Francisco, Calif., built the $60-million plant.

Penn-Olin Chemical Co. enters the industry picture as a joint subsidiary of Pennsalt Chemicals Corp. and Olin Mathieson Corp. New company will begin production of chlorate compounds at Calvert City, Ky., by the end of this month.

Ionics, Inc., Cambridge, Mass., announces acquisition of Elec-

YANKEE ATOMIC

trouble-free performance

installing more
than 70 miles of

SCOVILL®

INHIBITED ADMIRALTY

heat exchanger

TUBE

HIGH RELIABILITY . . . trouble-free performance . . . has become a very specific goal of engineers in the Atomic Age.

This applies whether the problem is reliability of controls in a space vehicle or reliability of the operating equipment in New England's first Atomic Power Plant at Rowe, Massachusetts, being designed by Stone & Webster Engineering Corporation in collaboration with Westinghouse and constructed by Stone & Webster.

Scovill salutes the Yankee Atomic Electric Company's project, where 11 future-minded New England Utilities have set a new milestone in a field of unlimited promise.

Scovill's contribution is HEAT EXCHANGER TUBING . . . mile upon mile of precision-built tube that shoulders a major responsibility for the trouble-free operation of this installation.

Here are shown being installed some of the more than 12,000, 30-ft. long Scovill Inhibited Admiralty Tubes (⅞" OD X .049" wall) specially made to extremely tight specifications for the main condenser in the Yankee Atomic Electric Company plant . . . over 70 miles of tube, every foot of which has passed the most rigid inspection.

Here, as elsewhere, Scovill Heat Exchanger Tube alloys and Scovill Technical Services have been recognized as among the finest available . . . to assure trouble-free performance.

HEAT EXCHANGER TUBE for Applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel, 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

SCOVILL

SCOVILL MANUFACTURING COMPANY

Mill Products Division, 99 Mill Street, Waterbury, Connecticut. Phone PLaza 4-1171.

1SC60

tron Arc., Inc., of Lynn, Mass. New Ionics division manufactures power transformers, rectifiers and control panels, will supply power needs for Ionics' commercial electrodialyzers.

American Marietta Co. has acquired the Dewey Portland Cement Co., has thus swelled its cement capacity to more than 22-million bbl./yr. Acquisition also permits AM to reach new cement markets in Oklahoma and Iowa, sites of present Dewey plants.

Hathaway Instruments, Inc., Denver, Colo., takes a tighter grip of markets for pneumatic control systems, by acquiring Clemco Aero Products, Compton, Calif. Clemco develops and manufactures actuators and dampers for jet and missile control applications.

International Minerals & Chemical Corp. has increased and relocated its technical services staff under a single ceiling: the new Technical Service Department. Organization of new department is geared to improve customer service with regional service assignments.

OVERSEAS BRIEFS

Morocco: Casablanca is the construction site of a new 20,000-ton/yr. calcium carbide plant. Locatelli S. p. A., an Italian corporation is building the plant under an agreement with the Moroccan Government at a cost of $2.5-million.

Italy: Montecatini Chemical Co. has begun construction of a giant 74-acre complex to produce nearly 75,000 tons/yr. of paint varnish and resin products. Concurrent with this announcement Dow

Chemica Italiana, S. p. A. reveals plans for construction of a polystyrene plant at an undisclosed site in Italy. Still another development is the laying of a petroleum pipeline from Genoa to Aigle, Switzerland, and the construction of a refinery at Aigle by Italo-Suisse of Geneva.

Netherlands: Dutch State Mines is laying the groundwork to triple polyethylene capacity at its Geleen plant: DSM is installing steam cracking facilities to produce ethylene from Esso-supplied, crude gasoline. Esso plans to purchase steam-cracking by-products from DSM.

Pakistan: Joint efforts of Bayer, Hoechst and Pakistan Industrial Development Corp. aim at establishment of a dye plant at Daudkhel. New facility will produce azo, congo-red and sulfuric-acid black dyes.

Spain's industrial development agency has authorized construction of the nation's first oil-regeneration plant, to recover used lube oil. The wealthy vasque, Ulibarri Alcarri, controls operation of the new 5,000-ton/yr. plant.

Indian Government is negotiating with competitive construction companies, Chemical Construction Co., Montecatini, Ansaldo, and John Brown, for a $24-million contract to build a fertilizer plant at Trombay. Plant, to be built under the third Five Year Plan, will produce some 70,000 tons/yr. of nitrogen for urea fertilizer manufacture.

Concurrent with these negotiations, Indian Government has awarded Vitro International a $4-million contract to design hot laboratories for the Atomic Energy Dept. at Trombay. Hot laboratory will feature master-slave manipulators for remote radiochemical operations and remotely operated overhead crane for transfer of radioactive materials from cell to cell.

In still another phase of the Indian industry, German companies: Bayer, Badische Aniline und Soda Fabrik, and Hoechst are building a dye-intermediates plant near Bombay. Intermediates plant will produce $21-million worth of product annually.

NEW LOCATIONS

Minnesota Mining & Manufacturing Co. moved its High Point, N. C., operations to newly-built facilities near the city of High Point. New location gives 3M company increased office and warehouse space.

Monsanto Chemical Co. centralizes division headquarters at St. Louis, Mo., to improve coordination of operations throughout the corporation. Lion Oil headquarters move from El Dorado, Ark.; Plastics Div. personnel shift from Springfield, Mass., other Monsanto divisions have already made the shift.

American Cyanamid's Plastics and Resins Division plans to move its executive offices from New York, N. Y. to Wallingford, Conn. By the month of August, Wallingford will be the hub of Azusa, Calif., Bridgeville, Pa. and Wallingford plastics manufacturing operations.

Floridin Co., supplier of adsorbent materials, has opened new sales offices in New York, St. Louis and Dallas. Floridin thus hopes to reach new markets for fuller's earth, activated bauxite and chromatographic adsorbents.

McKesson & Robbins is moving its chemical warehouse and offices to Stamford, Conn. New modern facilities will improve service to customers.

CALENDAR

American Oil Chemists Society, annual meeting.
April 4-6 Dallas, Tex.

American Management Assn., National Packaging Exposition and Conference, Convention Hall.
April 4-7 Atlantic City, N. J.

Instrument Society of America, New Jersey Section, all-day symposium: Computers in the Process Industry, Essex House.
April 5 Newark, N. J.

Building Research Institute, Paints and Coatings Conference, Statler Hilton Hotel.
April 5-7 New York, N. Y.

Instrument Society of America, National Chemical and Petroleum Symposium.
April 5-7 Rochester, N. Y.

American Society of Mechanical Engineers-Society for Advancement of Management, Management conference, Statler-Hilton Hotel.
April 7-8 New York, N. Y.

Management Seminar, sponsored by Cornell University, fee: $900, Statler Inn, Cornell Campus.
April 13-26 Ithaca, N. Y.

American Society of Mechanical Engineers-Institute of Radio Engineers-American Institute of Electrical Engineers, third annual conference on Automatic Techniques, Cleveland-Sheraton Hotel.
April 18-19 Cleveland, Ohio

Stanford Research Institute, Symposium: Chemical Reactions in the Lower and Higher Atmospheres, Mark Hopkins Hotel.
April 18-20 San Francisco, Calif.

American Society of Lubrication Engineers, annual meeting and exhibit, Netherland-Hilton Hotel.
April 19-21 Cincinnati, Ohio

Society of Plastics Engineers, technical conference: Plastics in the petroleum and chemical industries, Hotel Texas.
April 20 Fort Worth, Tex.

Oklahoma State University, heat-transfer conference.
April 20-22 Stillwater, Okla.

National Petroleum Assn., semi-annual meeting, Cleveland-Sheraton Hotel.
April 20-22 Cleveland, Ohio

Instrumentation for the Process Industries, symposium sponsored by Texas A. & M.
April 20-22 College Station, Tex.

German Industries Fair, Hanover Fair Grounds.
April 24-May 3 Hanover, W. Germ.

Society of the Plastics Industry, annual Canadian Section conference, London Hotel.
April 25-26 London, Ont.

American Society of Mechanical Engineers, Maintenance and Plant Engineering Conference, Chase-Park Plaza.
April 25-26 St. Louis, Mo.

American Society of Mechanical Engineers, Metals Engineering Div., AWS Conference, Biltmore Hotel,
April 25-29 Los Angeles, Calif.

American Welding Society, annual conference and exhibition, Great Western Exhibit Center.
April 25-29 Los Angeles, Calif.

Natural Gasoline Assn. of America, annual convention, Rise Hotel.
April 27-29 Houston, Tex.

Electrochemical Society, national meeting, Lasalle Hotel.
May 1-5 Chicago, Ill.

Instrument Society of America, Wilmington Section, national symposium: safety in electrical instrumentation, du Pont Country Club.
May 2-3 Wilmington, Del.

Western Joint Computer Conference, Fairmont Hotel.
May 2-6 San Francisco, Calif.

Canadian Dept. of Mines and Technical Surveys, Conference: Methods of Reducing Iron Ores, Lasalle Hotel.
May 3-5 Chicago, Ill.

Society of Chemical Industry, Chemical Engineering Group, International symposium on distillation, The Dome.
May 4-6 Brighton, England

Instrument Society of America, Instrument-Automation Conference and Exhibit, Brooke Hall and Civic Auditorium.
May 9-12 San Francisco, Calif.

Oklahoma State University, Industrial Operations Analysis Conference.
May 9-11 Stillwater, Okla.

Southwestern Metal Congress, and Exposition, Sheraton-Dallas Hotel and State Fair Park.
May 9-13 Dallas, Tex.

National Assn. of Corrosion Engineers, workshop clinic: organic coatings on ferrous surfaces, Hotel Niagara.
May 11-13 Niagara Falls, N. Y.

Fluid Controls Institute, Spring meeting, The Greenbrier.
May 11-14
White Sulphur Springs, W. Va.

American Institute of Industrial Engineers, annual meeting, Dallas Sheraton Hotel.
May 12-14 Dallas, Tex.

United States Army, national power sources conference.
May 17-19 Fort Monmouth, N. J.

Society for Experimental Stress Analysis, Spring meeting, Hotel Severin.
May 18-19 Indianapolis, Ind.

American Gas Assn., Production meeting, Roosevelt Hotel.
May 23-24 New York, N. Y.

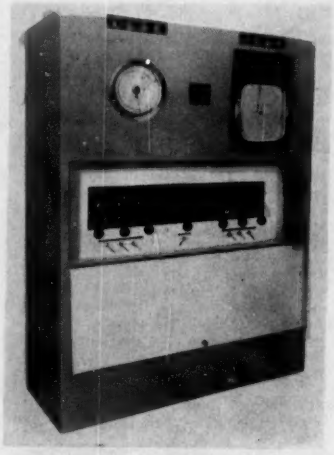
American Society for Quality Control, annual convention, Sheraton Hotel.
May 23-25 San Francisco, Calif.

Technical Assn. of the Pulp and Paper Industry, annual Coatings Conference, Edgewater Beach Hotel.
May 23-25 Chicago, Ill.

(*Continued from page* 100.)

trial surface. Spray gun continuously mixes liquid monomer with polymerization catalyst, by a tapered roller bearing rotating at 20,000 rpm.

Pressurized air (60-150 psi.) atomizes polymerized resin and forces it through the spray-gun nozzles; pressurized air also drives the mixer motor. And a single trigger controls all air and liquid flows to make operation simple.—**Binks Mfg. Co., Chicago, Ill.** 100E



Batching System

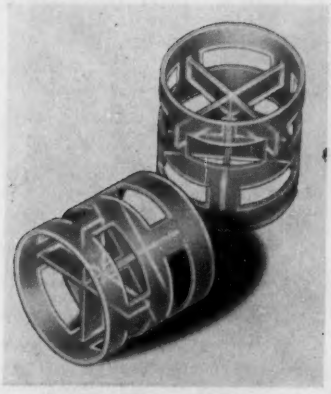
Automates formulation of bulk-materials products.

Capable of a weighing accuracy of ±0.25% calibrated range, and of reproducibility better than one part in 2,000, a new bulk-materials, batch-weighing system can program the weighing of two, three, four or more ingredients in any desired proportions. Once system parameters have been programmed, operation is fully automatic.

Feed and discharge devices, weigh hoppers and weight transmitters are individual equipment packages—they are unit assemblies that can be interchanged with building-block simplicity.

Standard read out and control facilities include: net-weight indication, batch-weight set, tare adjustment, hopper fill and

discharge signaling, and control-mode selection. Recording read out instrumentation is optional on this system.—**Weighing & Control Components, Inc., Hatboro, Pa.** 188A



Tower Packing

Enables substantial economies in tower supports.

Polypropylene is the material of construction for a new series of Pall ring tower packings. As such, these processing components combine light weight and wide chemical resistance with virtually the same low pressure drop at high mass-transfer efficiency as their metal counterparts.

Currently available in four standard sizes—⅝, 1, 1½ and 2 in. diameters—the new packing weighs only about 4½ lb./cu. ft. As such, it can be packed to a height of at least 25 ft. per support plate, providing worthwhile economies in tower construction. Maximum continuous operating temperature is 250 F. —**Process Equipment Div., The U. S. Stoneware Co., Akron, Ohio.** 189A

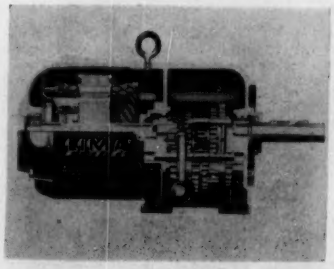
Vibration Absorber

Stops transmission of noise and vibration.

New vinyl chloride "Vibra-Check" pads absorb 90% of costly and annoying vibrations from reciprocating and rotating machinery. Pads act as mounts

for machines without lagging, cement or bolts.

Installation is instantaneous and machine relocation simplified, by positioning pads under the machine base. Suction cup pattern on pad surfaces and high coefficient of friction prevent machine sliding. And machines may be leveled by adjusting leveling screws, that bear down on metal shims between machine base and pad.—**Lowell Industries, Inc., Boston, Mass.** 189B



Multi-Speed Drive

New gear box for long versatile life.

Now available with ceiling, wall or floor mounts, the newly designed selective-speed drive provides as many as eight rotational speeds, when linked to a two-speed motor. And drive design features stress-proof steel shafting with hardened splines and lifetime sintered bushings for extreme service conditions.

Double-width seals, self-lubricating ball bearings and pressure-tight seals assure long leak-proof operation, even when the unit is vertically mounted.—**Lima Electric Motor Co., Lima, Ohio.** 190A

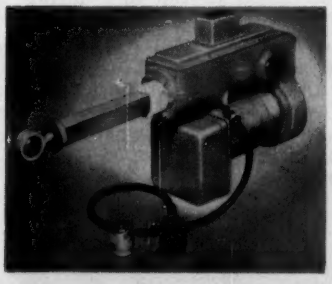
Digital Recorder

Compact, portable instrument claims new features.

Weighing only 100 lb., the new PS216-D 16-track, portable digital magnetic-tape recorder features modular construction and printed circuit board. Amplifiers are in compact, solid-state, plug-in form.

Each standard unit comes

with 1-in.-wide tape and the new PCM telemetry tape configuration of 16 tracks/in. Reels are standard size, standard tape speeds are 1⅞ to 60 in./sec.—**Precision Instrument Co., San Carlos, Calif.** 190B

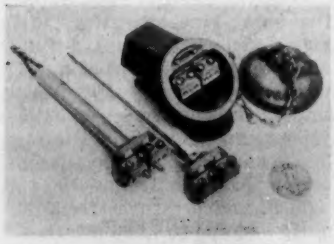


Linear Actuator

Suitable for most open-loop applications.

First of a new line of actuators designed for industrial use, the Lear Model 499B is a heavy-duty, electrically driven linear actuator suitable for use wherever open-loop positioning is required. The device can move up to ¾ of a ton, and can hold 1 and 1½ tons. A brake reduces overcoast to a minimum.

Stroke adjusts continuously from 4.25 to 5.25 in. A second version of the actuator, designated Model 499B-1, has a stroke of 2.75 to 3.75 in.—**Lear, Inc., Grand Rapids, Mich.** 191A



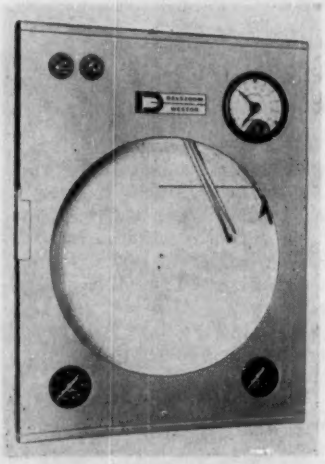
Connection Head

For sheathed or conventional thermocouples.

Rugged and weatherproof, the new Mini-head connection head for industrial thermocouples is designed for high-ambient temperature and corrosive-atmos-

phere applications. Made of semi-steel, the head contains a high-temperature refractory terminal block that fits B&S No. 7 gage or smaller wires, and B&S No. 12 or smaller extension wires.

Mini-head accommodates both conventional thermocouple wire-elements and the new metal-sheathed thermocouples featured in the manufacturer's Ceramicouple line. The item comes with a ¾-in. conduit outlet, and a choice of five protecting-tube outlet sizes: ¼ through 1 in.—**E. C. Smith Mfg. Co., Inc., Conshohocken, Pa.** **191B**



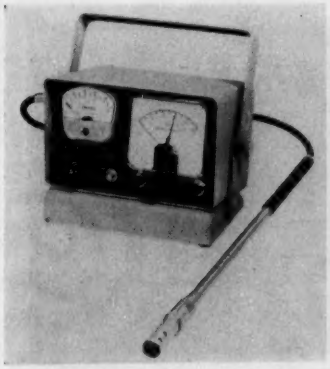
Batch Controller

Elapsed-time device controls, records operations.

When installed in the circuit of a batch-type operation, the new Model 7003 elapsed-time controller provides timed automatic regulation of either temperature or pressure (the systems are interchangeable). Charts and ranges are available for temperatures from —100 to 1,000 F. and pressures from 30 in. Hg vacuum to 7,500 psi. Control signal is pneumatic.

An external start button activates the controller; a red signal light indicates start of the process. As the measured variable approaches the control point, the timed phase of the cycle begins. When the preset timed period has elapsed, the controller automatically shuts

down, and the timer resets for a repeat cycle. Time ranges offered include 60 min., 5 hr., 12 hr., or 24 hr. Minimum setting of each time is equal to 4% of its range.—**Weston Instruments Div., Daystrom, Inc., Newark, N. J.** 192A



Gas Detector

All-purpose, indication/alarm instrument.

Operable as either a stationary or portable unit, the new Model 521 probe-type detector gives indication and alarm when gas concentrations reach unsafe levels. When fixed, the detector element may be located up to 100 ft. away from the meter. A solid electrolyte Ni-Cd battery and battery charger provides the portable power.

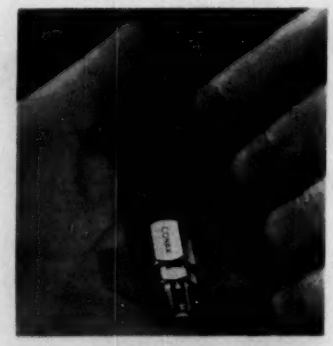
Indicator meter is calibrated in percent of lower explosion limit of desired gas. An adjustable meter trip provides an alarm circuit for the built-in buzzer. Readings are instantaneous and automatic. Priced at $425, the instrument comes with two spare detector elements stored for ready replacement.—**Houston Instrument Corp., Houston, Tex.** 193A

Pressure Regulators

Adaptable to steam, gas or liquid services.

Suitable for steam pressures to 300 psi. and temperatures to 600 F., a new line of sliding-gate pressure regulators are

available from stock in ½- through 2-in. body sizes. Special low-flow capacity seats are offered for reduced capacity requirements. Self-cleaning and self-lapping seats help reduce maintenance. Pressure drop to 250 psi.—**O. P. W.-Jordan, Cincinnati, Ohio.** **193B**



Thermocouple Gland

New miniature units protect thermocouple wires.

Here's a positive pressure seal for bare thermocouple wires that will withstand pressures from 0.005 microns to 5,000 psi. This new gland comes with or without thermocouple wires and may be reused simply by replacing its ceramic insulator and sealant.

New gland now permits more widespread use of bare-wire thermocouples, with their high rate response and low time constant for better temperature control.—**Conax Corp., Buffalo, N. Y.** **194A**

BRIEFS

Feeder valves with stainless-steel rotary vanes serve as pressure-tight air locks for pneumatic conveying of solids. External ribs and close-tolerance parts provide satisfactory service both under pressure and vacuum.—**Sprout Waldron & Co., Inc., Muncey, Pa.** **194B**

Plastic tanks of translucent resin offer visible liquid levels for the ultimate in batch volume control. Cali-

brations running the height of the tank assure accurate control.—**Jones & Hunt, Inc., Gloucester, Mass.** 194C

Pipe bending gage fits any hydraulic pipe or conduit bender, accurately indicates degree of bend of any pipe, ½ to 6-in. in dia.—**Greenlee Tool Co., Rockford, Ill.** 195A

Centrifugal pump line has been broadened by the addition of an 8- and two ¾-in. models. Liquid end of the ¾-in. sizes is constructed of Worthite, a corrosion-resistant metal. The 8-in. unit is a twin volute pump.—**Worthington Corp., Harrison, N. J.** 195B

Graphite heat exchangers in small models, 6, 13, or 24-in. long, are now available to handle flow rates up to 84,000 gal./hr. "Polybloc" heat exchanger design facilitates turbulent flow to prevent scale formation and promote high efficiency. — **Carbone Corp., Boonton, N. J.** 195C

Standard heat exchangers in sizes ranging to about 1,200 sq. ft. of surface are now available from Struthers Wells. Four design features are standardized into the line: Mechanical design; thermodesign around standard unit; pricing around standard unit; and a large, complete stock ready for shipment.—**Struthers Wells Corp., Warren, Pa.** 195D

Vertical centrifugal pumps, available in seventeen alloys to meet most corrosion problems in the temperature range from −300 to 750 F., come in fourteen sizes with capacities ranging from 5 to 500 gpm. at head from 10 to 120 ft. designed for inside or outside tank mounting.—**Dean Bros. Pumps, Inc., Indianapolis, Ind.** 195E

Vibrating feeder line has been expanded to more than 60 sizes by the addition of 49 new units, in two motor capacities. Of the new models, 31 are twin-motor feeders with capacities ranging from

275 to 1,700 tons/hr. And 18 of the new feeders are single-motor design; capacities vary from 5 to 525 tons/hr. All of the new, low-headroom devices will feed a wide range of materials. — **Link Belt Co., Chicago, Ill. 195F**

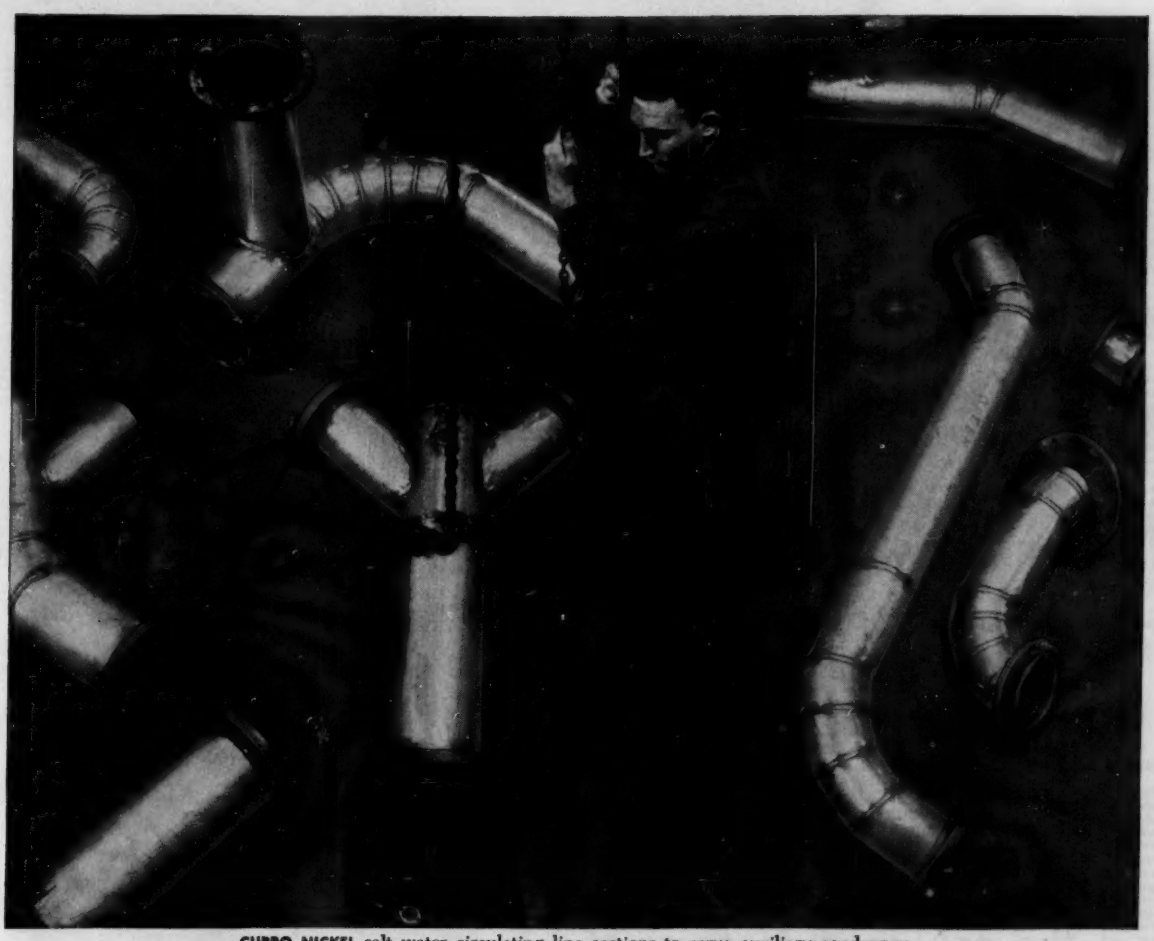
Coupling line known by the Sure-Flex trade name has been expanded by the addition of three junior sizes. Designed to provide smooth transmission of power, the smaller models claim peak horsepower ratings at 1,750 rpm. of 1.5, 3.0 and 6.0, to provide broad low-range flexibility.—**T. B. Wood's Sons Co., Chambersburg, Pa. 196A**

Pneumatic controllers of the Bristol Series 650 are now available with a metal bellows in the unbalanced detector. Recommended for batch-type processes with frequent startups, and for installations where ambient temperature is variable, the new controllers feature lower minimum gain, reduced drift and hysteresis and increased sensitivity.—**The Bristol Co., Waterbury, Conn. 196B**

Equipment Cost Indexes . . .

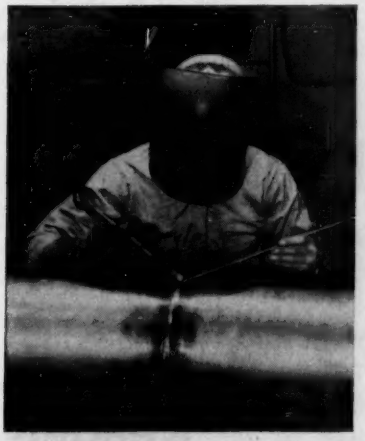
	Sept. 1959	Dec. 1959
Industry		
Avg. of all	235.8	237.0
Process Industries		
Cement mfg.	229.9	231.1
Chemical	237.5	239.0
Clay products	223.4	224.6
Glass mfg.	224.2	225.6
Paint mfg.	228.0	228.7
Paper mfg.	228.8	230.2
Petroleum ind.	232.9	233.6
Rubber ind.	235.7	236.5
Process ind. avg.	234.1	235.4
Related Industries		
Elec. power equip.	239.4	242.1
Mining, milling	239.0	240.4
Refrigerating	266.4	267.3
Steam power	223.2	223.9

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.



CUPRO NICKEL salt water circulating line sections to serve auxiliary condensers aboard gypsum rock carriers recently fabricated by Boro Marine & Industrial Corp.

Wide variety of Cupro Nickel piping for salt water lines is readily made from sheet by welding



Circumferential joints are welded manually. Longitudinal seams are welded in mechanized equipment by inert-gas, metal-arc processes.

Ever higher velocities in salt water lines and the growing economic importance of continuity in service, on shipboard, and also in tidewater power plants and oil refineries, are leading to increasing use of Cupro Nickel in piping.

Techniques and skills for economical fabrication of even the most complicated elements of Cupro Nickel piping systems are keeping pace. Boro Marine & Industrial Corp., Port Richmond, Staten Island, N. Y., a specialist in the field, forms piping in sizes 6" to 24" diameter from Anaconda Cupro Nickel stock sheet, usually 48" x 96" x 3/16". Elements shown above indicate the variety possible. Seamless tubing is used for smaller diameters.

Boro Marine fabricates piping from both Cupro Nickel 30%-702 and Cupro Nickel 10%-755. The trend, however, is to Cupro Nickel 10%-755 for the majority of salt water line installations on commercial vessels and in industrial jobs, according to M. E. Wuensch, president. The alloy was developed by Anaconda for this kind of service. It is resistant to corrosion by both clean and polluted sea water, even at relatively high velocity of flow, and is resistant to corrosion by sea water containing air bubbles.

TECHNICAL ASSISTANCE. For help in selecting the alloy best suited for a particular job in heat transfer and piping systems, call in your American Brass representative, or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA®

CUPRO NICKEL MILL PRODUCTS

Made by The American Brass Company

TIMELY
HELPFUL
FREE . . .

Timely, helpful, free. That's the kind of data, information and technical know-how that CE's Reader Service section can bring you.

Help yourself in this supermarket of ideas. All you need is a pencil and a postcard.

Here's what's available: More information on any advertised products or service; Latest technical literature (p. 208); Additional details on new chemicals and equipment described in this issue (pp. 88-100).

As you read this issue—pencil in hand—circle numbers on your Reader Service card. Your selections will be mailed to you promptly by the manufacturers. It's a mighty handy way to keep up-to-date with what's new in processes and products.

And why not take advantage of our offer of a free reprint for your files. Just put a check mark in the free reprint box on the card.

Chemical Engineering

Reader Service

For more information . . .

- Advertised Products
- New Equipment
- New Chemicals
- Technical Literature

- Classified Advertisements

Also . . .
- Reprints orders
- Subscriptions

Your Reader Service card is fastest.

USE EITHER CARD

They're easy to fold and tear out . . . try it . . .

*

PLEASE PRINT

NAME:

TITLE:

COMPANY:

PRODUCT:

ADDRESS:

CITY, STATE:

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—POSTAGE WILL BE PAID BY—

Chemical Engineering
READER SERVICE DEPARTMENT
330 West 42nd St.
NEW YORK 36, N. Y.

*

PLEASE PRINT

NAME:

TITLE:

COMPANY:

PRODUCT:

ADDRESS:

CITY, STATE:

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—POSTAGE WILL BE PAID BY—

Chemical Engineering
READER SERVICE DEPARTMENT
330 West 42nd St.
NEW YORK 36, N. Y.

Help Yourself . . .

The postcards above can now bring you technical help, latest literature, expert guidance. Tear one out and, as you read this issue, circle numbers when you want more information. You'll note that the coding system is simple: all the code numbers are page numbers.

You can also use these post-paid cards to subscribe, or to make your selection from a comprehensive list of editorial reprints.

*** Be sure to fill in these address blanks before mailing postcard.**

Send CE for ☐ 1 yr. at $3, ☐ 3 yr. at $5 (U.S. rate only) 7

To _____

CIRCLE code numbers for more information. (This April 4 issue card will expire July 4, 1960)

Cov	25	47	81	92E	100C	118b	165	186	192A	196B	209B	212C	L215	T220
1	26	48	83	93a	100D	118c	167	187	193	197	209C	T213	R215	B220
2	27a	49	85	93b	100E	118d	169	188	193A	198	209D	B213	L216	220A
4	27b	51	86	93d	101	118e	171	188A	193B	202	210	213A	R216	221
6-7a	28	52a	87	94A	102	118f	173	189	194	203	210A	213B	216A	T222
6-7b	29	52b	88A	94B	103	155	175	189A	194A	204	210B	213C	216B	B222
6-7c	30	52c	88B	94C	104	157	176	189B	194B	205	210C	213D	216C	222A
6-7d	31	53	88C	94D	105	159	177	190a	194C	206	210D	213E	L217	222B
8-9	32	54	89	97	106-107	161a	178	190b	195	207	210E	213F	R217	222C
10-11	37	56	90A	98A	108	161b	179	190c	195A	208	210F	L214	217A	222D
12-13	38	61	90B	98B	114	161c	L180	190A	195B	208A	210G	R214a	L218	222E
16-17	39	63	90C	98C	115	161d	R180	190B	195C	208B	210H	R214b	R218	L230
18-18	40	67	91	98D	116	161e	181	191	195D	208C	211	R214c	218A	TR230
20	41	69	92A	98E	117a	16,f	182	191A	195E	208D	211A	214A	L219	231
21	42	71	92B	99	117b	161g	183	191B	195F	208E	212	214B	R219	232
22	43	73	92C	100A	117c	161h	184	T192	196	209	212A	214C	219A	233
23	44	77	92D	100B	118a	163	185	B192	196A	209A	212B	214D	219B	234
24	45	79												

A B C D E F G H J K L M N O P Q R S T U V W X Y Z AA

REPRINTS: Circle what you want. (See opposite page for description.)

21	25	28	35	37	40	42	45	46	48	49	50	52	53	54	55	57	58	59	61	62	63
64	65	66	67	68	69	70	72	73	74	75	76	78	79	80	81	82	83	84	85	86	87
88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	105	107	108	109	110	111
112	113	114	115	117	118	119	120	121	122	124	125	126	127	128	129	130	131	132	133		
136	138	139	141	142	143	144	145	146	148	149	150	151	152	153	154	155	156	157			

FREE REPRINT: Check here ☐ for your file copy of this issue's reprint (p. 151) FC-33

Circle KEY NUMBERS for more information about . . .

- ADS
- PRODUCTS page 88
- EQUIPMENT page 94
- SERVICES
- LITERATURE page 208
- CLASSIFIED

REPRINTS (While they last)

Send CE for ☐ 1 yr. at $3, ☐ 3 yr. at $5 (U.S. rate only) 7

To _____

CIRCLE code numbers for more information. (This April 4 issue card will expire July 4, 1960)

Cov	25	47	81	92E	100C	118b	165	186	192A	196B	209B	212C	L215	T202
1	26	48	83	93a	100D	118c	167	187	193	197	209C	T213	R215	B220
2	27a	49	85	93b	100E	118d	169	188	193A	198	209D	B213	L216	220A
4	27b	51	86	93d	101	118e	171	188A	193B	202	210	213A	R216	221
6-7a	28	52a	87	94A	102	118f	173	189	194	203	210A	213B	216A	T222
6-7b	29	52b	88A	94B	103	155	175	189A	194A	204	210B	213C	216B	B222
6-7c	30	52c	88B	94C	104	157	176	189B	194B	205	210C	213D	216C	222A
6-7d	31	53	88C	94D	105	159	177	190a	194C	206	210D	213E	L217	222B
8-9	32	54	89	97	106-107	161a	178	190b	195	207	210E	213F	R217	222C
10-11	37	56	90A	98A	108	161b	179	190c	195A	208	210F	L214	217A	222D
12-13	38	61	90B	98B	114	161c	L180	190A	195B	208A	210G	R214a	L218	222E
16-17	39	63	90C	98C	115	161d	R180	190B	195C	208B	210H	R214b	R218	L230
18-18	40	67	91	98D	116	161e	181	191	195D	208C	211	R214c	218A	TR230
20	41	69	92A	98E	117a	16,f	182	191A	195E	208D	211A	214A	L219	231
21	42	71	92B	99	117b	161g	183	191B	195F	208E	212	214B	R219	232
22	43	73	92C	100A	117c	161h	184	T192	196	209	212A	214C	219A	233
23	44	77	92D	100B	118a	163	185	B192	196A	209A	212B	214D	219B	234
24	45	79												

A B C D E F G H J K L M N O P Q R S T U V W X Y Z AA

REPRINTS: Circle what you want. (See opposite page for description.)

21	25	28	35	37	40	42	45	46	48	49	50	52	53	54	55	57	58	59	61	62	63
64	65	66	67	68	69	70	72	73	74	75	76	78	79	80	81	82	83	84	85	86	87
88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	105	107	108	109	110	111
112	113	114	115	117	118	119	120	121	122	124	125	126	127	128	129	130	131	132	133		
136	138	139	141	142	143	144	145	146	148	149	150	151	152	153	154	155	156	157			

FREE REPRINT: Check here ☐ for your file copy of this issue's reprint (p. 151) FC-33

Circle KEY NUMBERS for more information about . . .

- ADS
- PRODUCTS page 88
- EQUIPMENT page 94
- SERVICES
- LITERATURE page 208
- CLASSIFIED

REPRINTS (While they last)

For Subscriptions: To apply, check here . . . . . (Pay when billed) Where to send subscriptions . . . . . .

Want More Data?

Use either of these two postcards for catalogs . . . for more information on equipment . . . on materials . . . on advertised items . . . for helpful reprints of editorial articles. Be sure to fill out the other side of cards. *Important—For pages showing more than one advertised item, use this guide to numbers on cards above.*

6-7a—Bromine and brominated compounds

6-7b—Chemical intermediates

6-7c—High density fluids

6-7d—Fire extinguisher fluids

27a—Blowers

27b—Industrial exhausters

117a—Equipment for butane propane

117b—Equipment for anhydrous ammonia

117c—Equipment for high pressure gases

118a—Plates

118b—Sheets

118c—Bars and angles

118d—Rings and discs

118e—Heads

118f—Pipe and tubing

R214a—Tanks

R214b—Industrial floors

R214c—Hoods, ducts, fume systems

Use this handy coupon to order your personal subscription to Chemical Engineering.
No need to send any money now. We'll bill you later.

READER SERVICE . . .

EDITORIAL REPRINTS

CE editorial reprints are now easy to get—use Reader Service Card for fast service. For each reprint you want just circle its number on the card. Fill in the blanks on the front, mail. You may send remittance if you wish.

• Materials of Construction

Corrosion—Refresher on cause & cure ($1)..... 131
Corrosion Resistance—16th Biennial Report ($1)..... 58
High-Temperature Materials—Inorganic, nonmetallic (75¢) 120
Industrial Plastics—How and where to use them (50¢)... 35
Lead Installations—Best designs for many uses (50¢)... 79
Metals for High Temperatures—18th Biennial report ($1) 129
Nonmetallic Inorganics—For severe conditions (50¢).... 125
Protective Lining—17th Biennial report ($1)..... 88

• Equipment

Computers—Digital & analog (50¢)..... 145
Control Valves—How to select yours (75¢)..... 141
Conveyors & Elevators—Solving bulk moving (50¢)..... 46
Heat Exchange Design—Timely shortcuts (75¢)..... 52
Heat Exchanger Calculations—12-part series ($1)..... 136
Instruments—"Hardware" section of Report 95 (50¢).... 96
Mechanical Seals—How to select and use them (50¢).... 83
Piping—Roundup of process pipe, valves, fittings (75¢). 40
Pumps—How to pick the one you need for your job (50¢) 21
Pump Seals—How to select the best (50¢)..... 92
Solids Feeders—How to lick feeding troubles (50¢)..... 28

• Processes

Adsorption—Design, methods, materials (50¢)..... 154
Biochemicals Processing—The total picture (50¢)..... 93
Bio-oxidation—Theory, design, practice (50¢)..... 68
Chemicals From Petroleum—Available processes ($1).... 139
Extractive Metallurgy—Via chemical engineering (50¢).. 111
Extremely Low Temperatures—Production and uses (50¢) 133
Fermentation—Its chemical technology (50¢)..... 74
Odor Control—How to be a god neighbor (50¢)..... 98
Moving Bed Processes—Application plus theory (75¢)... 64
Manufactured Gas—To supplement natural gas (50¢)... 115
Process Energy—Make or buy? (50¢)..... 142

• Costs and Other Timely Topics

Air Pollution—How to cope with problems (50¢)..... 143
Buyer-Seller Relations—Vendor's View (50¢)..... 157
Capital Cost Estimating—Data Sources and Methods ($1) 156
CE Cost File—Quick estimating data (50¢)..... 153
Cost Control Systems—How to build your own (50¢).... 102
Cost Estimation-III—17 articles, 80 pages ($1.25)..... 48
Cost Index—One-year bibliographic index (35¢)..... 65
Engineering with Models—Scale & test models (50¢)... 53
Flowsheets—How to speed communications (50¢)..... 99
Flow File—50 formulas (50¢)..... 112
Inflation—How to predict the shrinking dollar (50¢).... 78
Liquefied Compressed Gases—How to handle (50¢)..... 147
Lubrication—For chemical plant engineers (50¢)..... 50
Modernization—Plan '59 for profits (75¢)..... 128
Nuclear Industry—The role of chemical engineers (50¢) 89
Nuclear Wastes—Treatment and Disposal (50¢)..... 150
Operation & Maintenance—The impact of trends ($1)... 121
Patent Fundamentals—Timely review (50¢)..... 114
Photochemical Engineering—Uses, processes, reactors (75¢) 59
Pilot Plants—All the aspects of scale-up ($1)..... 127
Plants & Processes—Inventory of 1955 (75¢)..... 69
Plants & Processes—Inventory of 1956 (75¢)..... 84
Processes & Technology—Eighth Inventory 1958 (50¢).. 118
Professional Registration—For PE-minded ChE's (50¢)... 85
Rockets & Missiles—Airborne reactor problems (75¢).... 119
60's Challenge Chemical Engineers (50¢)..... 152
Speculative Process Design—Pilot plant bypass (50¢).... 146
Statistics—How to use data effectively (75¢)..... 73
10 Top Chemicals—Current trends (50¢)..... 132
Water Conservation—A factor to consider (50¢)..... 105
Water Pollution Control—To cope with problems (50¢).. 122

• Unit Operations

Binary Distillation—Theory, equipment (75¢)..... 54
Compressible Fluids—How to handle ($1)..... 80
Crystallization—For purification (50¢)..... 124
Drying—Methods, equipment, design, costs (75¢)..... 70
Entrainment Separation—Equipment & Performance (75¢) 37
Foams—How to use and how to control foams (50¢)..... 86
High Temperature Technology—Materials, processes (50¢) 91
Ion Exchange—A chronicle of remarkable advances (75¢) 55
Liquid-Gas Contacting—A practical operation study (75¢) 82
Liquid Proportioning—Equipment, methods, uses (50¢).. 76
Process Control—Up-to-date instrumentation report ($1).. 95
Size Reduction—Major pieces of equipment (50¢)..... 25
Solids Concentration—Survey of techniques (50¢)..... 67
Solids-Gas Contacting—Integrated background (50¢).... 63
Solids-Liquid Separation—Basic know-how ($1)..... 62

New and Popular Series . . .

Estimating Engineering Properties. By Wallace R. Gambill.
Thermal Conductivity (50¢).. 94
Heat Capacities (75¢)..... 109
Latent Heat (75¢)..... 117
Surface Tension (75¢)..... 126
Viscosity (75¢) 138
Critical Properties (75¢).... 149
Other Physical Properties (50¢) 151

GE Refresher
Thermodynamic Principles (50¢) 42
Compression & Expansion (50¢) 45
Chemical Equilibrium (50¢)... 49
Homogenous Kinetics (50¢)... 57
Catalytic Kinetics (50¢)..... 61
Interpreting Kinetics (50¢)... 66
Simple Reactor Design (50¢).. 72
Complex Reactor Design (50¢). 75
Catalytic Reactor Design (50¢). 81
Reactor Design Problems (50¢) 87
Physical Equilibrium I (50¢)... 90
Physical Equilibrium II (50¢).. 97
Fluid Flow Equations (50¢)...101
Fundamental Math (75¢).....113
Mass Transfer Operations ($1).130

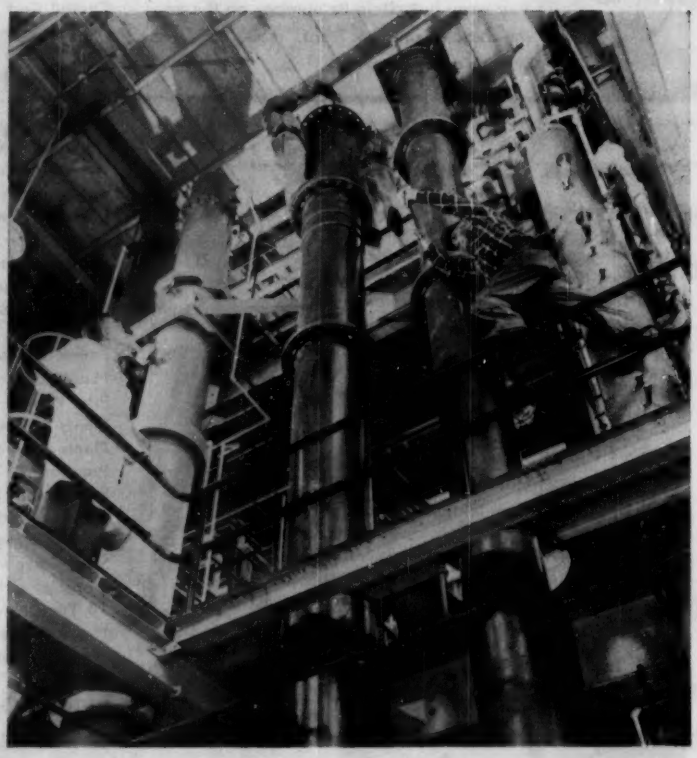
Unit Operations Refresher
Fluid Flow (50¢).....144
Sedimentation Theory (50¢)...148
Heat Transfer (50¢).....155

Flow Through Packing and Beds.
Packed Towers (50¢).....103
Fixed and Moving Beds (50¢).107
Fluidized Systems (50¢).....108

Your Design Reerence File.
Parts I-V (75¢).....100
Parts VI-IX (75¢).....110

TECHNICAL BOOKSHELF

J. B. BACON



Plastics semiworks: They work to make books obsolete.

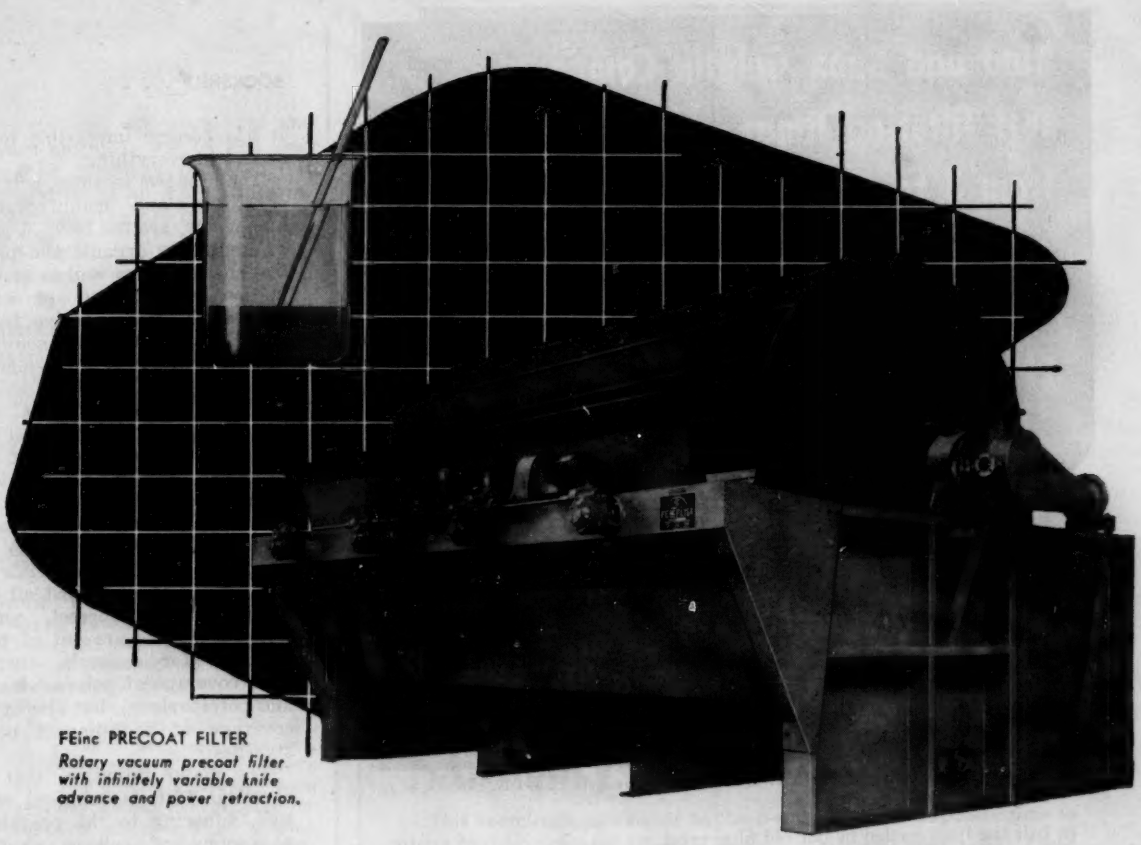
Clear Perception of Purpose

POLYMERS AND RESINS—Their Chemistry and Chemical Engineering. By Brage Golding. D. Van Nostrand & Co., Princeton, N. J. 744 pages. $15.

Reviewed by Allan L. Griff, Union Carbide Plastics Co., Bound Brook, N. J.

Dr. Golding has attempted a monumental feat, and, considering this, he has done very well. Under the noses of hundreds of technologists working furiously to make his book obsolete, he has collected a vast amount of plastics chemistry *and* engineering know-how into one intelligible volume.

As expected in such a fast-growing field, there are some good chapters and some already obsolescent chapters, and the two can be rather sharply separated —which is in itself an advantage, because it makes the book very useful to certain groups of people (chemists, students). To this reviewer, this is far better than having it slightly useful to everyone, which is the only other realistic alternative. In plastics,



FEinc PRECOAT FILTER
Rotary vacuum precoat filter with infinitely variable knife advance and power retraction.

Custom Filter Design

BEGINS WITH YOUR FILTRATION PROBLEM

Your processing requirements are king at FEinc. They dictate the type of filter to be built, its size, the materials used, and the special refinements necessary to assure highest possible operating efficiency.

For example, a FEinc Precoat Filter designed to meet your particular needs pays off fast in trouble-free operation, dryer cake discharge and high clarity of effluent.

If you require higher output in limited floor area and a long filtration cycle coupled with the above advantages, FEinc *custom design* can give it to you.

Send us your filtration problems. Specific recommendations provided without obligation.

See our insert in Chemical Engineering Catalog.

For a Bigger Yield **FE INC.®**

FILTRATION ENGINEERS
AMERICAN MACHINE AND METALS, INC.
EAST MOLINE, ILLINOIS

STRING HORIZONTAL SCRAPER

SPECIALISTS IN LIQUID-SOLIDS SEPARATION

it has become impossible to be expert in everything.

The first two sections, polymer chemistry and manufacturing technology, are the best. A good grounding in organic and physical chemistry, as well as mathematics, is needed to appreciate the work. The extensive treatment of natural and modified-natural products is commendable.

By contrast, the applications and fabrication sections are brief, and often out of date. (The *average* publication date of the references for the applications chapter is 1949—and in plastics, that's old.) The reader should avoid making comparisons of importance among materials or methods. Although most all the information is correct, sometimes emphases are out of proportion; for example, there's good coverage of polycarbonates and polyethylenes, but almost no coverage of high-impact polystyrenes.

The major intention, that of a college text, is achieved very well, adhering to the prevalent philosophy of college plastics education: heavy in chemistry, less in engineering, lightest in applications and fabrication techniques. This is good preparation for research chemists and process development engineers. These, also, are the people to whom the book will be useful as a reference, as they will understand it.

The many other technologists of plastics—in product development, technical sales or service, production, and end-use (the people who buy and use the plastics)—these may find this book long, complicated, and often inadequate in their areas. Unfortunately for them, there is really no better *general* source. Such people must turn to works in specific areas, or better yet, to specific people, for study and experience. A critical bibliography of such specialized books, consultants, and companies would be very welcome.

Dr. Golding writes with an unusually clear perception of his task. His sole authorship has contributed logical organization and consistency of style (a good one, too—not overly pedantic). In the more technical areas, this book is a valuable contribution.

Its students will work hard and learn much. It will be well used on the chemist's bookshelf. It should be in all major libraries where plastics are made, served, or used.

BRIEFLY NOTED

EVALUATION OF CATALYSTS FOR HYDROGENATING SHALE OIL. 29 *pp. By H. C. Carpenter and P. L. Cottingham. Bureau of Mines Publication-Distribution Section, 4800 Forbes Ave., Pittsburgh 13, Pa. Free.* Compares results obtained with 17 different catalysts in hydrogenating crude shale oil to gasoline in single-pass operation.

FIFTH WORLD PETROLEUM CONGRESS, PROCEED'NGS. *Eleven volumes, 282 papers. Limited number of volumes available from American Petroleum Institute, Publication Section, 1271 Avenue of the Americas New York 20, N. Y. For congress members, $7.50 per copy, $70 for complete set. For others, $12.50 per copy plus 50¢ mailing charge, $110 for complete set plus $5.50 mailing charge.* Proceedings of congress held last summer in New York.

GAS-LUBRICATED BEARINGS, A CRITICAL SURVEY. 298 *pp. By G. F. Boeker, D. D. Fuller and C. F. Kayan. Order PB 151946 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.* $4. Summarizes work on hydrodynamic gas-lubricated thrust and journal bearings; presents design data for air-bearing machines.

MORE NEW BOOKS

STRUCTURE AND PROPERTIES OF THIN FILMS. Edited by C. A. Neugebauer, J. B. Newkirk and D. A. Vermilyea. Wiley. $15.

MAN-MADE TEXTILE ENCYCLOPEDIA. Edited by J. J. Press. Textile Book Publishers, Interscience. $27.50.

CATHODIC PROTECTION. By Lindsay M. Applegate. McGraw-Hill. $9.

AVAILABLE ENERGY AND THE SECOND LAW ANALYSIS. By Edward A. Bruges. Academic Press. $5.50.

ELECTROCHEMICAL ENGINEERING, 4th ed. By C. L. Mantell. McGraw-Hill. $16.50.

LETTERS:

Eliminate the Radical

Sir:

I would like very much to have the flowsheet index which you offered free to subscribers in your Jan. 11 issue (p. 178).

Incidentally, I believe I may have found an error in your CE Refresher feature for Nov. 30, 1959. On p. 85, first column, under (3), the authors discuss the mean value of the area for heat transfer, A_m. Although they carry out the integration correctly to arrive at $A_m = (A_1A_2)^{0.5}$, A_m does not equal $4\pi(x_1x_2)^{0.5}$ nor $\pi(D_1D_2)^{0.5}$, but merely $4\pi(x_1x_2)$ and thereby $\pi(D_1D_2)$.

TOBY T. ZETTLER
Cleveland, Ohio

Sir:

Mr. Zettler is correct. I was trying to make the point that the mean area, $(A_1A_2)^{0.5}$ in this situation, is also πD^2 or $4\pi x^2$ where D and x are the geometric mean values of the diameter $(D_1D_2)^{0.5}$ and of the radius $(x_1x_2)^{0.5}$ respectively. I'm sorry I failed to catch this mistake.

BERNARD S. PRESSBURG
Louisiana State Univ.
Baton Rouge, La.

Add Five Dynes

Sir:

The chart on physical properties of water published as part of the Gambill series (Apr. 6, 1959, p. 140) shows values for surface tension which do not agree with the references cited.

This error, I believe, is a printer's mistake, for the values appear to be uniformly 5 dynes/cm. higher in the literature than on the graph.

DOUGLAS B. HOLMES
Rice Institute
Houston, Tex.

► *Our thanks to an alert chemical engineering senior for spotting this error. Readers may correct their graphs by adding 5 to the surface tension scale, i.e., the graduations originally marked 25, 50 and 75 should read 30, 55 and 80.*—ED.

PRO & CON

C. H. CHILTON

Con: Union Challenge

Sir:

Until the professional societies, including the proposed American Engineers' Assn. (Feb. 22, p. 53), are as good as the American Medical Assn. at getting money, protective legislation and restricted entry into the profession, we shall see much greater success on the part of labor unions.

The engineering societies are largely controlled by high corporation executives, i.e., those employing most of the membership. It is almost as bizarre to expect them to make life better for the engineer as for chemical workers to join the Manufacturing Chemists' Assn.

Mr. Hartsook (Feb. 22, pp. 145-149) evidently considers engineers "part of management" with, automatically, the same opinions. This reminds me of Mr. Krushchev's dictum that Soviet workers "can't strike against themselves."

All the talk about "professionalism" can't disguise the insecurity and other indignities of many working engineers, notably in that part of engineering which serves Mr. Hartsook's own industry.

JOHN E. ULLMANN
Stevens Institute of Technology
Hoboken, N. J.

▶ *We're not sure whether Prof. Ullmann's allusion to MCA was intended to be of the camel-through-the-needle's-eye type. Membership in MCA is open only to corporations manufacturing chemicals.*— ED.

Pro: Editorial Efficiency

Sir:

I would like to thank you for publishing my article, "Estimate Working Capital Needs" (Feb. 22, pp. 127-128). I was impressed by the smooth and efficient manner in which your staff works. Assistant Editor Bill Schall was particularly helpful.

LOUIS R. BECHTEL
Atlantic Refining Co.
Philadelphia, Pa.

READER SERVICE . . .

TECHNICAL

Contents of This Issue

Chemicals

Admixtures for Concrete.....Maracon Admixtures are highly effective water reducing agents & plasticizers for concrete. Complete data and booklet available.
208A Marathon Div. of American Can

Acrylic Monomers.....Collection of literature that should prove to be a valuable working tool to the tech. man engaged either in commercial or development operations, offered.
67 *Rohm & Haas Co.

Activated Carbon.....is the most versatile liquid and gas purifier. All types are manufactured. Literature J-103 is now available on your request.
198 *Barnebey-Cheney

Aluminum Alloys.....24-page booklet gives physical properties, fabrication characteristics and economic advantages. Various tempers, finishes and patterns are available.
208B Olin Mathieson Chemical Corp.

Cast Alloys.....Revised list of standard designations and chemical composition ranges for heat and corrosion resistant cast alloys includes 32 grades. Available upon request.
208C Alloy Casting Institute

Caustic Potash.....You can buy Nialk caustic potash in Standard and Low-Chloride Grades in thirteen different ways. More information in data sheet.
93a *Hooker Chemical Corp.

Chemicals.....Technical brochure on chemicals for the rubber industry includes antiozonants, antioxidants, adhesives, coating materials etc.
208D
Eastman Chemical Products Inc.

Chemicals.....Brochure describes products and services; covers reorganization of three sister firms. Lists 46 chemical and metallurgical products for manufacturing.
208E Vitro Corp. of America

* From advertisement, this issue

LITERATURE

E. M. FLYNN

Coagulant Aids.....Bulletin contains information on material used to speed up and improve coagulation and sedimentation in municipal water clarification systems.
209A Hagan Chemicals & Controls, Inc.

Diatomite.....High bulk, irregular particle shape & large available surface area suit Celite to hundreds of mineral filler applications. Technical data offered.
77 *Johns-Manville

Expoxidation Process.....Patent on in-situ epoxidation using ion-exchange resins as catalyst has been granted to Becco. Further information on request.
42 *Becco Chem. Div., FMC

Epoxy Repairing Compound.....Data sheet describes two new low cost materials with good tensile and compressive strength used for repairing machinery, etc.
209B Devcon Corp.

Fluorides.....Major uses of Fluorides are in the petroleum, glass, steel and atomic energy industries. The newest fluoride is silicon tetrafluoride.
28 *The Harshaw Chemical Co.

Friction-Reducing Additive.....Data sheet describes agent that can pump pressures or double injection rates in water, brine or acid. Graph illustrates friction reduction.
209C Dowell Div., Dow Chem.

Ion Exchange.....Booklet discusses ion exchange applications & techniques, contains valuable data on the Dowex ion exchange resins designed for process applications.
189 *Nalco Chem. Co.

Latex Thickeners.....Technical booklet contains detailed information on viscofier that stabilizes and thickens. Explains hows and whys of complex technique.
209D Alco Oil & Chemical Corp.

Phosphorus Trichloride.....A clear and water-white liquid. 99.9% pure. No free phosphorus. Additional information contained in Phosphorus Trichloride Data Sheet.
93b *Hooker Chemical Corp.

* From advertisement, this issue

Want to build up your files and keep them up-to-date? You can get any publication in this comprehensive guide — free — just for the asking.

It's easy — simply circle item's number on the Reader Service Postcard and mail. Replies will come directly from companies offering the literature.

LITERATURE . . .

Plasticizers.....are shipped from convient points. Facts on phosphate and epoxy plasticizers including complete specifications are available on request.
79 *Celanese Chemical Co.

Polymer Stabilizer.....Data sheet describes tributyl aconitate as a plasticizer-stabilizer for vinylidene chloride polymers and coplymers. Includes applications and toxicity.
210A Chas. Pfizer & Co., Inc.

Polyethylene Film.....14-page booklet contains complete packaging and marketing specifications for all standard films. Schematic drawings, charts and formulas are also given.
210B Chippewa Plastics Co.

Polyethylene Glycols.....40-page booklet gives extensive technical information. Includes data on physical and physiological properties, solubilities, viscosities and tensions.
210C Union Carbide Chemicals Co.

Potassium Carbonate.....for process gas scrubbing the hot circulating carbonate solution does away with costly heat exchangers & reduces steam requirements.
89 *Allied Chemical, Solvay Process

Solvents.....To help you choose the solvent system for your formulations, the 6-page "Solvent Selector" is offered. Information on all glycol-ethers & 32 other solvents.
81 *Union Carbide Chem. Co.

Synthetic Rubber.....Bulletin describes heat and ozone resistant solution that can now be imparted to insulations and coatings where molding is undesirable.
210D Pelmor Laboratories, Inc.

Tetraethylene glycol.....Bulletin on liquid desiccant used to remove water from natural gas. Material may be used in conventional glycol absorbtion dehydration plants.
210E Jefferson Chemical Co.

Thermoplastic.....Bulletin descibes physical and electrical properties of polycarbonate resin. Comparison with other plastics given to show combination of characteristics.
210F Bobay Chemical Co.

Trichlorethylene.....Data sheet giving full information on specifications, description, and uses of trichlorethylene is available on your request.
93c *Hooker Chemical Corp.

Vacuum Metallizing.....45-page booklet describes in detail application and use of vacuum metallizing coatings that may be applied by spraying, dipping, and flow coating.
210G Bee Chemical Co.

Viscosity Stabilizer.....Technical report describes materials that reduce "free water" in paste formulas. Proper viscosity is maintained despite agitation, etc.
210H Morningstar-Paisley, Inc.

Construction Materials

Alloys.....Technical assistance in selecting the alloy best suited for a particular job in heat transfer and piping systems is available to you.
197 *The American Brass Co.

* From advertisement, this issue

Alloys.....Full information on Haynes corrosion resistant alloys, their properties, forms and the corrosives they will resist is now available. Copy of 104-pg. book.
171 *Haynes Stellite Co.

Castables.....Alundum are ideal for furnace conditions in all types of atmospheres at temp. up to 3,300 F. New catalog with complete characteristics & casting instructions.
31 *Norton Company

Casting Alloy....."HOM" is a special high nickel alloy developed to produce castings that meet high temperature requirements. Additional information.
210 *The Duraloy Co.

Coating.....Kanigan applies a hard, corrosion-resistant nickel alloy coating. You can plate anything from a small relief valve to a 20,000 gal. tank car. Information.
175 *Gen'l American Transportation.

Ductile Iron Pipe.....for a wide variety of piping applications in the chemical & petroleum industries. Illustrated booklet includes dimensions & weights charts.
202 *James B. Clow & Sons, Inc.

Gaskets.....Ajax spiralwound flange and boiler gaskets are immediately available from shelf stocks in popular types and sizes. Complete stock list available.
188 *Belmont Packing & Rubber Co.

Gaskets.....The gold Flexite Finish for the metal gauge rings in Flexitallic Compression-Gauge Gaskets offers high corrosion resistance. Samples available.
99 *Flexitallic Gasket Co.

Insulation.....A complete line of insulation accessories for use with Foamglas. Copy of Gulf Cast Study report & copy of the Industrial Insulation Catalog available.
115 *Pittsburgh Corning Corp.

Insulation, Pipe.....is available in full range of standard pipe sizes & in block form. Single thickness to five inches. Specials to 44" O.D. Bul. No. 65610.
73 *Union Asbestos & Rubber Co.

Insulation Piping.....Bulletin describes molded fiberglass pipe-fitting insulation that claims thermal insulating advantages over conventional pipe fitting materials.
211A Fibrous Glass Products Inc.

Lead Products.....These products include chemical lead sheets to your requirements; pipe, bends, traps and standard fittings. Lead Hand-Book Bulletin No. 162.
103 *American Smelting & Refining

Mechanical Seals.....are completely interchangeable with packing. External and internal seals available from vacuum to 100 psi. Bulletins L218
*Chemical & Power Products, Inc.

Metal, Corrosive-Resistant.....Hortonclad is produced through a patented continuous bonding process. Hortonclad bulletin outlines structures for corrosive materials.
21 *Chicago Bridge & Iron Co.

Packing.....Dura Plastic Teflon Packing is particularly suitable for sealing rods, shafts & stems on processing equipment handling hot caustics, acids, etc. Bul. 461.
R215 *Durametallic Corp.

* From advertisement, this issue

LITERATURE . . .

Packings.....Viton fluoroelastomer offers outstanding resistance to oils, fuels, solvents & chemicals, as well as to elevated temp. Specific data on heat & fluid resistance.
54 *E. I. du Pont de Nemours

Plastic Steel.....is a combination of approximately 80% steel & 20% of a newly developed plastic. Can be formed into any shape. Illustrated booklet.
212A Devcon Corporation

Protective Coatings.....Plasite cold set coatings are formulated from high resistant resin combinations to achieve highest chem. resistance possible. Bulletins.
L216 *Wisconsin Protective Coating

Refractories.....Bulletin containing extensive tech. information on the properties & application of refractory-type products plus copy of "Super Refractories" offered.
167 *Carborundum

Rubber Linings.....offer permanent protection against corrosion & contamination. Permanent rubber-to-metal bond. Resistant to acids, alkalis, etc. Catalog No. 7115.
37 *Raybestos-Manhattan, Inc.

Tantalum.....Technical data bulletin 3.506-2 contains engineering information and typical examples of acidproof Tantalum for the chemical industry.
212B Fansteel Metallurgical Corp.

Wire Cloth.....from any metal or alloy including titanium. In nine basic weaves from finest to coarsest mesh. A 94-page catalog is now offered.
22 *The Cambridge Wire Cloth Co.

Electrical & Mechanical

Gearmotors.....in a wide variety of sizes in single, double, triple or quadruple reductions, horizontal or vertical foot or flange mountings. Bul. MU-227.
32 *Wagner Electric Corp.

Gears.....Information on U.S. Syncrogear features in Syncrogear Bul. F-1880, Right-angle wormgear Syncrogear Bul. F-1650, 1994.
233 *U. S. Electrical Motors, Inc.

Motors.....Super-Seal motors, with Silco-Flex insulation feature advancements such as capsule bearings, split end housings, and Integrated field coils.
85 *Allis-Calmers

Motors.....28-page catalog lists hundreds of geared and non-geared electric motors from 1/2000 to 25 HP. Complete prices and electrical information is also given.
212C B & B Electric Motor Co.

Motors.....Features include, top-mounted gas-to-water cooler, oil pump, motor & oil filter, inert-gas temperature gauge, etc. Additional features in Bulletin No. 226.
102 *Electric Machinery Mfg. Co.

Motors.....SEALEDPOWER totally-enclosed fan-cooled motors include explosion-proof designs in all ratings up to 300 hp. Newest data given in Bulletin PB 6000.2.
194 *Elliott Co.

* From advertisement, this issue

Motors & Generators.....A copy of the data and specification file on Electric Motors and Generators is now available for your ready reference on request.
56 *Marathon Electric Mfg. Corp.

Speed Reducer.....Torque-Arm line offers you capacities up to 170 hp. output speeds from 10 to 400 rpm. A 64-pg. bulletin complete with engineering data & selection tables.
18-19 *Dodge Mfg. Corp.

Turbine, Vertical.....has an almost indestructible rotor. It is available in capacities from 5 to 300 HP. Bulletin S-137 gives complete information.
20 *The Terry Steam Turbine Co.

Handling & Packaging

Air Hoists.....Piston and Rotary air hoists popular models available from 150-4000 lbs. Sparkproof construction & pendent control are offered.
187 *Gardner-Denver Co.

Belt Conveyor Idler.....Bulletin gives information on construction of idler that consists of series of neoprene discs molded to cable suspended from two end bearings.
213A Joy Manufacturing Co.

Bucket Elevators.....Catalog covers both belt and chain elevators in single and double casing design. Standard series range in capacities from 280 to 8835 per cu ft per hr.
213B Andrews Machine Co.

Packaging.....The Duette sewn multiwall bag valve-on-a-valve gives double sift protection for granular, pelletized and also pulverized products.
83 *Bemis Bro. Bag Co.

Packer.....The new Force Flow packer includes pneumatic-mechanical controls throughout, plus availability in 1, 2, 3, or 4-tube models. Literature offered.
63 *St. Regis Paper Co.

Payloader.....is a dependable performer with many exclusive features. There are 20 models to choose from for your needs. Complete data on new H25 "Payloader".
43 *The Frank G. Hough Co.

Pressure Feeder.....Leaflet describes feeder used to load bulky material of low density or extremely wet materials into continuous screw presses under pressure.
213C The Bauer Bros. Co.

Materials Handling Equipment..... Illustrated brochure covers every feature of the FT Series Lift Truck. Includes engine specifications, accessories, attachments, etc.
213D Allis-Chalmers

Screw Conveyor.....60-page guide gives information on selection and engineering of proper conveyor setup to meet specific requirements. Lists 300 materials.
213E Fort Worth Steel & Mach. Co.

Tank, Single Shell.....for surge, balance or intermediate holding, for blending, & for accumulating ingredients. Bul. B-1468 lists dimensions & specifications.
213F The Creamery Package Mfg. Co.

* From advertisement, this issue

LITERATURE . . .

Steel Drums.....Illustrated 12-page booklet discusses varied applications for corrosion-resistant metals and variety of uses for shipping and process drums.
214A Inland Steel Container Co.

Weighing Instrument.....Flexure Plate leverage system controls processing or materials handling by weight. Literature on its application to filling and batching.
207 *Thayer Scale

Heating &Cooling

Air Heaters.....Type CA heater can be used in a wide variety of installations & with either gas, oil or combination firing. No refractory required. Bulletin #104.
209 *Thermal Research & Engr. Corp.

Air Preheater.....Information on the Ljungstrom continuous regenerative principle, or on the Air Preheater that meets your requirements is available.
104 *The Air Preheater Corp.

Boilers.....Design and construction of fully automatic horizontal type boilers given in 12-page catalog. Includes information on standard equipment and special features.
214B Lookout Boiler & Mfg. Co.

Boilers.....Vapor Modulatic water tube boilers furnish high or low-pressure steam (at design pressures up to 1000 psi, or even higher). Bulletins offered.
185 *Vapor Heating Corp.

Burner Systems.....Complete units for any commercial grade of fuel oil, any commercial gas (including sewer gas.) Performance data contained in Bulletin 1255.
179 *Orr & Sembower, Inc.

Dryer.....Bulletin D959 describes the DehydrO-Mat. Pictures typical installations and includes a schematic drawing of the DehydrO-Mat showing its component parts.
214C Edw. Renneburg & Sons Co.

Generators.....for all your steam problems. If you need 10 to 600 HP you can get information on the Amesteam Generators and obtain a copy of the catalog.
51 *Ames Iron Works

Generators, Inert Gas.....offer precise fuel control & automatic safety. If you need inert gases for blanketing, purging & protective uses, see Bulletin L-10.
157 *The C. M. Kemp Mfg. Co.

Heat Exchanger Tube.....for applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers in popular Alloys.
181 *Scovill Mfg. Co.

Heat Exchangers.....20-page engineering manual contains cutaways, diagrams and design data on impervious graphite exchanger. Principles of operations are given.
214D The Carbone Corp.

Heat Transfer.....New Multi-Zone Plate-coil design cuts "downtime" & compensates for intermittent overload in a wide range of tank & process heating applications. Bul.
45 *Tranter Mfg. Inc.

* From advertisement, this issue

LITERATURE . . .

Heaters.....More than 15,000 different types, sizes and ratings of electric heaters and heating elements. Catalog 60 contains General Industrial heating applications.
86 *Edwin L. Wiegand Co.

Heating Systems.....Aroclor systems deliver steady process heat. Information booklet on Aroclor 1248 heating systems and guide to heater selection offered.
177 *Monsanto Chemical Co.

Modular Exchanger.....permits limitless exchanger capacity by adding units as required. Unit is self supporting, easily converted to other applications. Lit.
161d *Falls Industries, Inc.

Panelcoil.....New heavy gauge embossed Panelcoil available in 5 widths from 12" to 29", in lengths up to 143". Data Sheet 15-60 Series & Price Bul. 259 offered.
R180 *Dean Products, Inc.

Parallel Exchanger.....with extremely simplified design. All passages drilled in single heat transfer section without joints. Easily cleaned. Literature.
161c *Falls Industries, Inc.

Steam Traps.....Information on trap capacity ratings, plus data on how to correctly size, install & maintain for any pressure, temp., or load. A 49-page Book.
108 *Armstrong Machine Works

Steam Traps.....Selector Chart in Strong Catalog No. 69A gives trap recommendations for 45 types of equipment. Steam Traps for every type of service.
97 *Strong, Carlisle & Hammond

Instruments & Controls

Analyzer, Heat Proven.....Two meters on the analyzer show per cent by volume of oxygen & combustibles on either a 20% range span or a more sensitive 4% range. Facts.
105 *Bailey Meter Co.

Cell Transmitters.....The d/p Cell Transmitters are the basis of your control system. Never need recalibration. Full details contained in Bulletin 13-11A.
159 *The Foxboro Co.

Colorimetric Comparators.....give you fast accurate tests for pH, chlorine, phosphate in just 3 simple steps. Handbook has 101-pgs. of tech. data & useful information.
R218 *W. A. Taylor & Co.

Controller.....The new Frac Controller adjusts column operation to the effects of ambient temp. on overhead product condenser & external reflux. Details.
10-11 *Minneapolis-Honeywell

Data Processing System.....The new IBM 1620 is a desk-size engineering computer. Solves problems like; reactor design, mass spectrometry, kinetics, etc.
69 *International Business Machines

Dial Thermometer.....Both vapor tension and gas-filled types are available in either distant reading or rigid stem types. Catalog offered on request.
B192 *Marsh Instrument Co.

* From advertisement, this issue

Gauges.....Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12". Cat. 300B.
114 *Manning, Maxwell & Moore, Inc.

Indicator.....The portable "Mini-Mite" indicator with 23" scale & 0.25% scale accuracy can be used to indicate on-the-spot temp. or calibration & test work. Details.
44 *Thermo Electric Co., Inc.

Instrumentation.....The design and process engineer's guide to industrial temperature measurement and control thru Mercury-Bulb instrumentation is available.
216A The Partlow Corp.

Meters.....Complete description of Niagara Chemical Meters, including High Pressure, Steam-Jacketed, and Electricontact Models, contained in Bulletin 43.
184 *Buffalo Meter Co. Inc.

Pressure Transducer.....Pamphlet includes design features and specifications of flush-mounted strain gage transducer designed for pressure measurement.
216B Consolidated Electrodynamics

Temperature Regulator.....available in sizes ½" to 1½". Temperature ranges as low as 15 F. to 50 F.—as high as 240 F. to 350 F. Information.
24 *Manning, Maxwell & Moore, Inc.

Water Meters.....Disc meters available from ⅝" to 2"; turbine meters, from 2" to 12" inclusive. Handle flows to 212 F. Designed for heavy industrial service. Lit.
B213 *Badger Meter Mfg. Co.

Pipe, Fitting, Valves

Expansion Joints.....Catalog 56 contains complete & comprehensive engineering data for Expansion Joints from 3" to 50' diam., pressures to 3600 psi, temp. to 1600 F.
41 *Zallea Brothers

Fittings, Flanges & Unions.....Folder PF-1 contains complete data on quantities & weights of the items as packaged in various sizes of cartons.
155 *Henry Vogt Machine Co.

Flexible Connectors.....“MNH” flexible connectors dampen vibration, compensate for misalignment, permit offset movement, & absorb expansion. Alliflex bulletin.
T222 *Allied Metal Hose Co.

Flexible Hose.....Booklet describes hose designed for steam transmission. Pure bronze wire braid reinforcement and solid brass swaged fittings counteract effect of steam.
216C Titeflex Inc.

Valves.....Ram type drain valves are designed so that in the closed position the piston or ram extends up into the tank. In open position, full flow is assured. Catalog.
L180 *Strahman Valves, Inc.

Valves, Angle.....are designed on piston principle. Positive, drip-tight shuto™. Can't over-tighten. Sizes 1" thru 4". Literature available on request.
161g *Falls Industries, Inc.

* From advertisement, this issue

LITERATURE . . .

Valves, Ball.....provides straight-through flow without turbulence. Double sealed. Full-open to full-closed in quarter turn. Sizes 1″ and larger. Literature.
161b *Falls Industries, Inc.

Valves, Control.....8-page booklet gives construction details, operating characteristics and specifications. Includes section on valve sizing and flow co-efficients.
217A Conoflow Corp.

Valves, Control.....Single Port furnished in 1″ and 1½″. Inner valve available to ¼″ diameter. Split construction for easy service. Literature.
161e *Falls Industries, Inc.

Valves, Control.....Double port design in 2″ and larger. Available characteristics include quick-opening, equal percentage, & linear. Literature on request.
161f *Falls Industries, Inc.

Valves, Diaphragm.....Rubber or plastic-lined cast iron, or solid plastic bodies. Sizes ½″ to 6″. Liquids never touch metal. Facts available on request.
190c *American Hard Rubber Co.

Valves, Diaphragm.....Furnished with hand wheel or electric, pneumatic, or hydraulic operators. Sizes 1″ to 8″. Leak proof and drip-tight. Literature.
161a *Falls Industries, Inc.

Valves, Drain.....Designed expressly to eliminate possible clogging of drain outlets in tanks. Provides automatic clearing of outlets. Sizes 2″, 3″ & 4″. Lit.
161h *Falls Industries, Inc.

Pipe.....All purpose rigid PVC in schedules 40, 80, & 120, ½″ to 4″. Threaded or socket-weld fittings. Valves ½ to 2″. Further information in Bul. CE-56.
190b *American Hard Rubber Co.

Pipe, Plastic.....Ace-Ite, chemical-resistant rubber-resin blend pipe is the surest way to stem the tide of corrosion. Handles most chemicals. Bulletin CE-80.
190a *American Hard Rubber Co.

Pipe, PVC.....Koroseal PVC pipe is lightweight, resists acids, corrosion, aging, weather & abrasion. It will not support combustion, is an excellent insulator. Details.
1 *B. F. Goodrich

Process Equipment

Air Separators.....offer precise separation and improve screening. Nine models are available with diameters from 3′ to 18′. Additional information in Bull. No. 087.
L215 *Sturtevant Mill Co.

Centrifugals.....Batch-O-Matic can handle highly corrosive materials under exacting standards of purity. Illustrated details plus information on Tolhurst machines.
205 *American Machine & Metals

Centrifugals.....Reineveld centrifugals are used extensively for dewatering & washing of crystalline solids & for separation & clarification of fine amorphous slurries.
T213 *Heyl & Patterson, Inc.

* From advertisement, this issue

LITERATURE . . .

Chlorinator.....A booklet "The V-notch Story" will tell you about all the V-notch chlorinator features. Also information on both gravimetric & volumetric feeders.
178 *Wallace & Tiernan Inc.

Collector.....The Mikro-Pulsaire is a simplified unit that provides full-time automatic cleaning with constant low-differential pressure. Sizes & capacities in Bul. 52A.
75 *Mikro Products

Continuous Dewatering Presses..... Catalog "A" contains complete information that can help you with your Pressing, Drying problems.
B220 *Davenport Machine & Foundry

Continuous Dryers.....Kathabar Humidity Conditioning Units; Air heaters instead of individual burners; Laboraotry Facilities for testing products. Facts available.
208 *Surface Combustion

Converters.....Chemical and plastic converters are available in a variety of sizes. Many new features for smoother operation. Complete information.
T220 *Mitts & Merrill

Dryers.....Small lab & table models, from tray & truck dryers, through huge capacity, multi-section, multi-stage conveyor dryers & rotary dryers. Details.
30 *C. G. Sargent's Sons Corp.

Dryers.....Technical data on three new model high velocity dryers. 4-page bulletin lists air outlet velocities ranging from 15,000 to 20,000 feet per minute.
218A J. O. Ross Engineering

Dryers & Coolers.....New 36-pg. catalog gives complete story . . . drying principles, advantages, applications, direct or indirect heat dryers & coolers, feeders, etc.
23 *The Jeffrey Mfg. Co.

Drying Systems.....Fluid Bed type dryer unit offers high thermal efficiency, & continuous, automatic, dust-free operation. Small space requirements. Bul. 88.
116 *Combustion Engr., Raymond Div.

Dust Control.....A new 28-pg. brochure "Freedom From Dust" includes full technical & application data on the complete line of dry collection equipment.
48 *Dracco Div. of Fuller Co.

Entrainment Separator.....Type MV offer complete corrosion resistance . . . low pressure drop . . . simple construction. Details contained in Catalog Section S-6900.
91 *National Carbon Co.

Filter.....The Eimcobelt continuous belt drum filter can handle even the most difficult slurries. The filter medium is always clean. Bulletin F-2053.
Cover *The EIMCO Corp.

Filter, Rotary Vacuum.....Handles slow or fast filtering solids. The design permits multi-stage countercurrent washing & features fume-tight operation. Bulletin.
2 *Bird Machine Co.

Filters.....New filter cuts filtering time in half, reduces labor costs and saves on floor space. More information in Bulletin NC-457.
204 *American Machine and Metals, Inc.

* From advertisement, this issue

LITERATURE . . .

Filters.....8-page bulletin describes multiple-surface porous stainless steel filters that can meet a wide range of flow rates, temperatures, pressures and slurries.
218B Pall Corp.

Floats, Stainless Steel.....New booklet includes construction data, application information, shape specifications, weight tables, buoyancy formulas, etc.
TR230 *Chicago Float Works

Gas Diffuser.....The Cavitator is a new method of rapid, low-cost diffusion of a gas into a liquid by mechanical agitation. Illustrated & described in Bul. 150.
219A Yeomans Brothers Co.

Hammer Mills.....feature extra heavy manganese steel liners & breaker plates, oversize shafts, massive parts & reinforcements. Facts in catalog.
29 *Williams Patent Crusher

Lectrodryer.....The standard Type BZ operates between 40 to 150 psig. Special units are available for 300 psig & higher pressure. Details in Bul. BZ-161.
211 *Pittsburgh Lectrodryer Div.

Lubricator.....start, stop, speed up and slow down in perfect synchronization with your machinery . . . unaffected by high steam, gas or air pressure. Catalog.
195 *Manzel

Mixers, Batch.....Capacities: 5 qts. to 160 cu. ft. Hand & motor driven models. All sizes available in stainless steel, other alloys. Easy to keep clean.
T192 *Daffin Mfg. Co.

Process Equipment.....Details on methods & equipment such as liquid vapor separators & wet and dry-type dust scrubbers or gas filters for tough separation problems.
R217 *Peerless Mfg. Co.

Process Equipment.....Bulletins giving complete information on rotary kilns, primary & secondary gyratory crushers, jaw crushers, apron feeders, are offered.
40 *Traylor Engineering & Mfg.

Pulverizer.....The Pulvocron is available in 20 and 38-inch grinding chambers and constructed of carbon or stainless steel. Can pulverize hard or soft materials.
101 *The Strong Scott Mfg. Co.

Reactors.....Glassed steel reactor that can be used with all acids except hydrofluoric at temperatures to 350 F is described in 12-page bulletin. Includes schematic drawings.
219B The Pfaudler Co.

Ribbon Blender.....features all welded construction, approved sanitary design, extra heavy shafts and ribbons. Brochure.
L219 *Falcon Mfg. Div., First Mach. Corp.

Safety Heads.....Quik-Sert Safety Heads offer leak-tight pressure relief assembly for your pressure systems. Complete details available on request.
183 *Black, Sivalls & Bryson, Inc.

Sifter.....The Cirlyptic Sifter is available in 3 models. For milk powder, pharmaceuticals, pre-mix foods, crystals, flour, chemicals, and abrasives.
196 *Entoleter Inc.

* From advertisement, this issue

LITERATURE . . .

Spray Nozzle.....“Cant-Clog” spray nozzle for air washers, cooling towers & spray equipment. Self-cleaning, installed in seconds. Ratings & Complete information.
L217 *Carrier Corp.

Strainers, Pipe Line.....Screwed, ¼” to 3”; pressures to 600 psi. Socket-weld, ¼” to 3”, pressures 600 & 1500 psi. Flanged, ½” to 5”, pressures to 600 psi. Bul. S-205.
39 *Yarnall-Waring Co.

Strainers.....The strainer elements & housings are designed and built to your specific requirements. Additional information contained in Catalog.
R216 *Multi-Metal Wire Cloth Co.

Pumps, Fans, Compressors

Blowers.....Type “E” are compact husky units in 5 sizes up to 5500 cfm, for constant pressures up to 2 lbs. Full details are contained in Bulletin FM-900.
27a *Buffalo Forge Co.

Blowers.....Bulletin illustrates & describes the 3-Lobe Rotary Positive Blowers & Exhausters. Includes operating specifications & capacity charts.
191 *M-D Blowers, Inc.

Compressed Air Dryers.....Brochure “Moisture Control” contains information on method of machines adaptable to any air system. Will intercept acid fumes.
220A Van Products Co.

Compressor.....FE-Horizontal, balanced compressor is built in a wide range of combinations, of crankthrows, cylinder arrangement & for pressures up to 15,000 psig.
16-17 *Chicago Pneumatic

Compressor.....The WB two-stage design saves floor space, pump circulates cooling water around cylinders & separate valve chambers. Bulletin WB-10 gives details.
186 *Gardner-Denver Co.

Exhausters.....Industrial Exhausters are available in designs with heat slinger for moving hot gases (200 to 850 F.). Bulletin FI-100 contains additional information.
27b *Buffalo Forge Co.

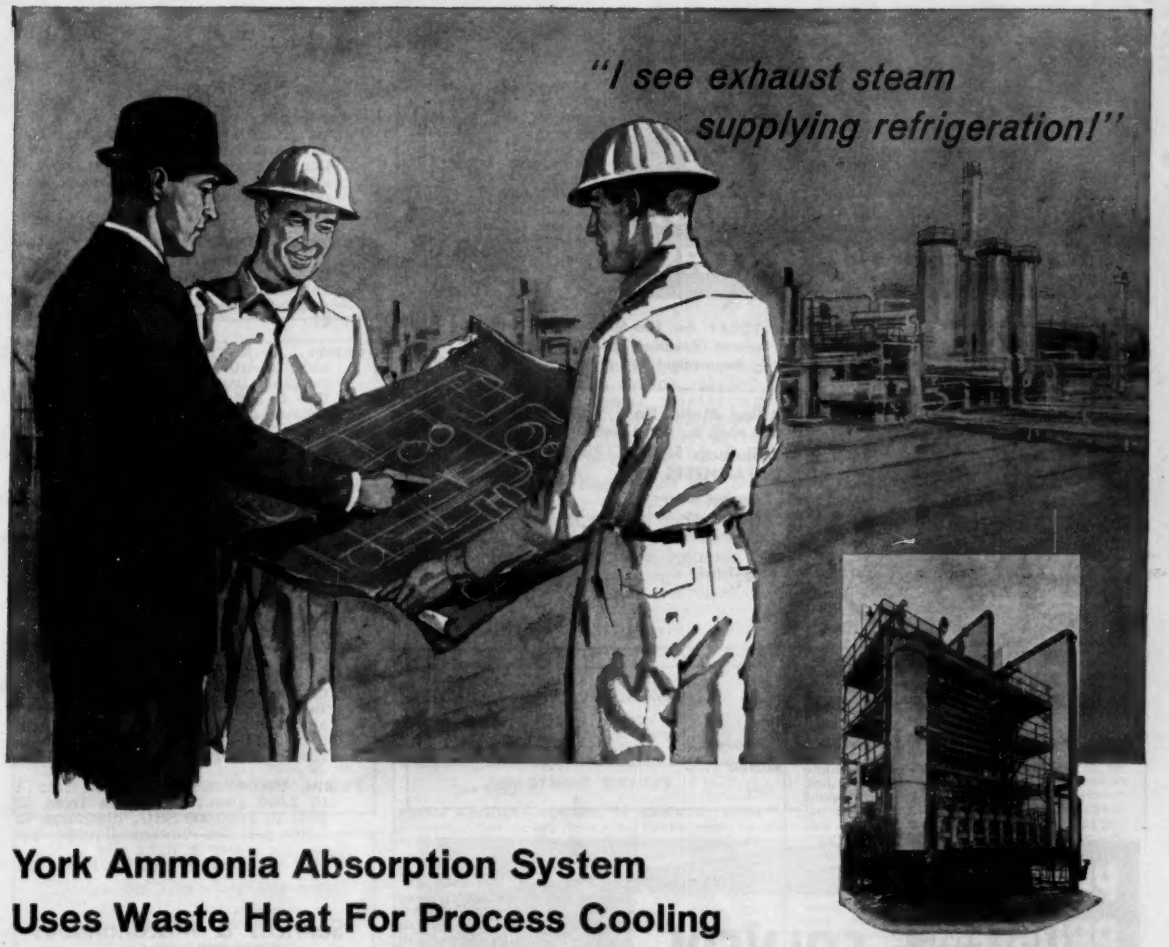
Pump.....The 3715 handles a wide range of corrosive liquids. Ten sizes. Temperatures to 350 F. Capacities to 720 GPM, heads to 280 feet. Bulletin 725.4.
52a *Goulds Pumps, Inc.

Pump.....The Model 3775, available in steel & any of the stainlesses, handles temp. to 600 F. because of its cooled support, bearing & seal chamber construction. Facts.
52b *Goulds Pumps, Inc.

Pump.....Hastelloy “C”, a highly corrosion-resistant nickel-chrome-molybdenum alloy is now available on Model 3604. Bulletin with performance chart & information.
52c *Goulds Pumps, Inc.

Pump.....Complete information on the No. 20 Type SQ open impeller pump is now available. Many advantages of the fully open impellers on these pumps.
4 *The LaBour Co., Inc.

* From advertisement, this issue



York Ammonia Absorption System Uses Waste Heat For Process Cooling

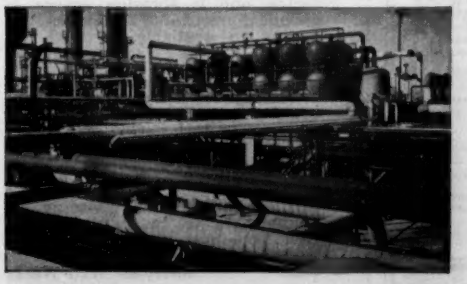
—Can operate unattended for long periods

VERY ECONOMICAL OPERATION—Utilizes exhaust steam from steam turbine driven equipment, hot oil, stack gases or waste heat from any source to provide refrigeration. Also can be direct-fired, if desired. York absorption units save substantially over conventional motor-driven compressor systems.

COMPLETELY AUTOMATIC—A few simple instruments control the system. These need no adjustment and are easily operated by average personnel. Flexible system operates from 100% to 0% capacity with almost constant efficiency, and is unaffected by sudden load changes and refrigerant "slop-over."

VIRTUALLY MAINTENANCE-FREE—Aqua ammonia pump is the only moving component in the entire system. This assures quiet, vibration-free operation and lowest possible maintenance. An extra aqua ammonia pump "spares" the system very economically and eliminates profit-cutting down-time.

INSTALLS OUTDOORS—Rugged construction eliminates need and expense of a building enclosure. Ideal for petro-chemical processing situations, or where indoor space is limited. Also adaptable for ammonia recovery. Capacities from 50 to 5,000 tons refrigeration for temperatures down to −90°F.



Another YORK Trail Blazer Concept Proved In Action at *Cities Service, Lake Charles, La.*—York Ammonia Absorption System uses waste heat from process vapors to deliver economical cooling at this Butadiene plant. Two-stage system provides 3,350 tons capacity—1,133 tons at 45° F. to cool spheroids and 2,217 tons at −5° F. for lean solvent cooling.

YORK YORK BW DIVISION

BORG-WARNER
RESEARCH & ENGINEERING
MAKE IT BETTER

YORK CORP., SUBSIDIARY OF BORG-WARNER CORP.
4994 SOUTH GRANTLEY RD., YORK, PENNSYLVANIA
In Canada—Canadian Ice Machine Co., Ltd.

Air Conditioning, Heating, Refrigeration and Ice-Making Equipment • Products for Home, Commercial and Industrial Applications

LITERATURE . . .

Pumps.....Durcopumps are produced in standard, self-priming & vertical submerged designs. Pumps are available with heads to 345 ft. capacities to 3500 gpm. Lit.
165 *The Duriron Co., Inc.

Pumps.....from zirconium and titanium. A new 8-page Table gives typical dynamic corrosion resistance values of zirconium & titanium. Available on request.
47 *Eco Engineering Co.

Pumps.....Moyno pumps are available in nine sizes with capacities ranging from minimum metering flow to 500 gpm and pressures from zero to 1000 psi. Bul. 30 CE.
49 *Robbins & Myers, Inc.

Pumps.....For your pumping or installation problems valuable information is contained in catalog series CC and series SP-507. Available on request.
B222 *Viking Pump Co.

Pumps, Proportioning.....Feed precisely metered fluids or slurries in all ratios with controlled process variables. Bulletin covers 100 series and 200 series.
L214 *American Meter Co.

Pumps, Rotary.....Folder outlines many cost saving advantages of submersible rotary pumps in storage tank service. Several typical installations are described.
222A Sier-Bath Gear & Pump Co.

Pumps, Screw.....Capacities from 1 to 2,000 gpm.; viscosities from 32 SSU to 1,000,000 SSU; discharge to 1,000 psi. for viscous liquids, 200 psi. for water & light oils.
176 *Sier-Bath Gear & Pump Co.

Services & Miscellaneous

Acid Gold Plating Process.....New 6-page paper describes metallurgical properties, operational data, & uses of acid-type industrial gold electroplating formulation.
222B Sel-Rex Corp.

AEC Research Reports.....Semi-annual list of all unclassified reports acquired to January 1960 by OTS. Includes listings on approximately 5000 documents.
222C OTS, U. S. Dept. of Commerce

Ammonia Absorption System.....uses waste heat for process cooling. Can operate unattended for long periods. Also adaptable for ammonia recovery.
221 *York Corp.

Filter Paper......"Netone" features high tensile strength, high burst factor, and is abrasion, crease & chemical resistant. Samples for testing are available.
212 *The National Filter Media Corp.

Polyvariable Experimentation.....4-page brochure describes new methods for experimentation in 10, 20 or more variables. Contains information on training programs.
222D Statistical Eng. Institute

Waste Disposal.....24-page booklet includes information on activated sludge process, mechanical aeration, screening, grit removal, etc. Installation pictures included.
222E American Well Works

* From advertisement, this issue

PROFESSIONAL SERVICES

E. J. CORELL
ENGINEER
Chlorine—Soda Ash—Perchlorethylene
Pigments and Related Products
Design—Reports—Operation
42 Rose Blvd, Akron, Ohio — Tele: Akron, O. TE 64271

CARL DEMRICK
Technical Translations
Send for Circular
53 So. Broadway, Yonkers, N. Y.

THE KULJIAN CORPORATION
Consultants • Engineers • Constructors
Chemical • Industrial • Process
1200 N. Broad St., Phila. 21, Pa.
Offices Throughout the World

PETER F. LOFTUS CORPORATION
Design and Consulting Engineers
Electrical • Mechanical • Structural
Civil • Nuclear • Architectural
First National Bank Building
Pittsburgh 22, Pennsylvania

FOSTER D. SNELL, INC.
Chemical & Engineering Consultants
Research, Process Development, Pilot Plant Studies. Plant Design. Location Studies Construction Supervision. Start-up & Operation. Equipment Design. Packaging & Materials Handling Studies. Cost Analyses. Trouble Shooting
29 W. 15th St. WA-6-8800 New York 11, N. Y.

When you need a SPECIALIST in a hurry . . .

Chemical Engineering's Professional Service Section offers the quickest, most direct method of contracting consultants who may be available NOW.

CLASSIFIED . . .

EMPLOYMENT OPPORTUNITIES

CE's nation-wide coverage brings you tips and information on current opportunities in job functions throughout the chemical process industries.

▶ **Coverage** — National Executive, management, engineering, technical, sales, office, skilled. Positions vacant, positions wanted, civil service, selling opportunities, employment agencies and services, labor bureaus.

▶ **Displayed Rates**—$54 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Subject to the usual agency commission.

▶ **Undisplayed Rates** — $2.10 per line, 3 lines minimum. To figure advance payment count 5 average words as a line; box number counts as 1 line. 10% discount if full payment is made in advance for 4 consecutive insertions. Not subject to agency commission.

▶ **Closing Date**—May 2nd issue closes April 8th. Send new ads to Chemical Engineering, P. O. Box 12, New York 36, N. Y.

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

EMPLOYMENT SERVICES

Better Positions—$6,000 to $50,000. Want a substantial salary increase, more opportunity or different location? This national 49 year old service connects you with best openings. You pay us only nominal fee for negotiations; this we refund when employer pays placement fee. Present position protected. In complete confidence, write for particulars. R. W. Bixby, Inc., 553 Brisbane Bldg., Buffalo 3, N. Y.

POSITION WANTED

Young Engineer, wide experience and practical knowledge of Petro-chemicals and petroleum products; seeks challenging sales/engineering post. Will relocate internationally. PW-4005, Chemical Engineering.

"Put Yourself in the Other Fellow's Place"

TO EMPLOYERS

TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

MR. EMPLOYEE you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section.

We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division
McGRAW-HILL PUBLISHING CO., INC.
330 West 42nd St., New York 36, N. Y.

Editorial Position

Immediate opening on Chemical Engineering's editorial staff of 19 engineer-editors for another young engineer to solicit, evaluate, edit or write technical news stories or articles on process and engineering developments and trends in the chemical process industries. Unusual opportunity to broaden industry and professional contacts, education and experience. Requirements: Degree in chemical engineering or closely related field, with 1-5 years experience in chemical process work; ability to evaluate chemical process and engineering information; able to write clearly, concisely and accurately; must like and work well with people; initiative and imagination. New York City location with opportunity for some out-of-town travel. Please send complete resume of education, experience, salary requirement and other pertinent information to:

Personnel Dept.
McGraw-Hill Publishing Co.
330 West 42nd Street
New York 36, New York

SALES ENGINEER

Well known Manufacturer of Heavy Duty Crushing and Grinding Machinery has opening for experienced man. Salary and commission, welfare and retirement plan. Midwest location. Give full details of past experience in first letter. Replies confidential.

P-3934, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

RESEARCH DIRECTOR
$15,000
Young agressive organization desires man on PHD or Masters' level to assume complete charge of a department engaged in research and development in the polymer, rubber, plastics and adhesive field. Client assumes all expenses.
MONARCH PERSONNEL
28 E. Jackson, Chicago, Illinois

CLASSIFIED . . .

EQUIPMENT SEARCHLIGHT

CE's Searchlight spots the big bargains in used, resale and rental equipment. Check this issue's listings—most complete in the field—for items you need now

▶ **Coverage** — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶ **Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶ **Closing date** — May 2nd issue closes April 8th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

CHEMICAL EQUIPMENT DIVISION

Raymond 3 Roll #3036 Hi-Side Mill
Buflovak 19 Shelf Vacuum Shelf Dryers
1000 sq. ft. Stainless Heat Exchangers (2)
Fletcher 30" Susp. S.S. 10/5 H.P. Centrif.
Fletcher 40" Susp. Steel Centrifugal
Oliver 5'3"x3' Stainless Precoat Filters
Sweetland #12, #10, #7 Filter Presses
Komarek Greaves 27" x 24" Presses
Nooter 750 gal. Steel Reactor 300 PSI
Link Belt 502-16 Roto-Louvre Dryer
8'x80' Rotary Dryer 316 S.S.
Traylor 11' x 155' Rotary Kiln
Vulcan 9'x100' Rotary Kiln
Standard 5'x45' Rotary Dryer
Mosser 4'x47' Rotary Dryers
Louisville 6'x50'; 6'x25' Steam Tube Dryer
F. J. Stokes 38A & 382A Tray Dryers
Stainless Tanks 100, 200, 350 gal.
Condensers 100 to 5000 sq. ft. Steel; Admir.
Pressure Vessels 300 to 4500 gal.
Towers and Columns 3' to 10' Dia.
J. H. Day 800# S.S. Jktd. Powder Mixer

HEAT & POWER CO. INC.
60 E. 42nd St., New York 17, N. Y.
310 Thompson Bldg., Tulsa 3, Okla.

CIRCLE A ON READER SERVICE CARD

2—Heating Votators Girdler cylinder size 10" x 62" vertical SS T 304 complete with 50 hp motors

2—Cooling Votaters Girdler cylinder size 24" x 72" nickel chrome heat transfer tubes, all other parts in contact with product 304 SS, complete with drive and 40 hp motors

THE CHEMSTRAND CORP.
DECATUR, ALABAMA
Attn: C. G. Hudson

CIRCLE C ON READER SERVICE CARD

NEED EXTRA CAPITAL?

WE PAY TOP DOLLAR FOR IDLE MACHINERY

MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE B ON READER SERVICE CARD

FOR IMMEDIATE SALE

JEFFREY BUCKET ELEVATOR

Heavy Duty, Stainless casing and 8x5 Buckets, 25' centers, Gear Head Motor Drive. Like New.

NORTZ
67 Van Reipen Ave. Jersey City, N. J.
Tel. OLdfield 3-4360

CIRCLE D ON READER SERVICE CARD

PIPE

2,000,000 ft. 2"	3.50¢ to the foot
1,000,000 ft. 3"	7.70¢
1,000,000 ft. 4"	10.98¢
500,000 ft. 6"	19.80¢
200,000 ft. 8⅝"	28¢
400,000 ft. 10¾"	35¢
75,000 ft. 12¾"	40¢
10,000 ft. 16"	42¢

All No. 1 Grade Plain End and Cleaned
INDIANA-OHIO PIPE CO.
P.O. Box 5412 Shepard Sta. Phone CL 3-5527
COLUMBUS 19, OHIO

CIRCLE E ON READER SERVICE CARD

S.S. Blender 150 cubic ft.
Blaw-Knox 2 gal S.S. Autoclave 5000 lbs.
50 gal S.S. Autoclave 2000 lbs. pressure
3½ gal S.S. Autoclave 2000 lbs. pressure
Vulcanizer 60" x 9' 125 lbs.
Sweetland #2 all stainless
Stainless steel Ball Mill
Proctor & Schwartz finned drum driers

MACHINECRAFT CORPORATION
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. Mi 2-7634

CIRCLE F ON READER SERVICE CARD

FOR SALE

HEAT EXCHANGERS—12 Units manufactured by Foster-Wheeler, 79 to 520 sq. ft. heating surface, type 316 SS tubes and crown sheets.

2—SS Selectro 3 deck 18" x 4' screens, like new.
Rotex Mod. 41, 40" x 120" double deck screens.
Kux Mod. 25 Rotary Tablet Press, dbl. action.

Send us a list of your idle surplus

AARON EQUIPMENT CO.
9370 Byron Street
Schiller Park, Illinois
Gladstone 1-1500

CIRCLE G ON READER SERVICE CARD

2—5' x 8' BALL TUBE MILLS

2—5' x 8' Kennedy Van Saun Air Swept Ball Tube Mills with disc feeders, fans, piping, all motors and electric eye mill level controls.

R. C. STANHOPE, INC.
Tel. MU 2-3076 or MU 2-1898
60 E. 42nd St. New York 17, N. Y.

CIRCLE H ON READER SERVICE CARD

FOR ADDITIONAL INFORMATION

About Classified Advertising

Contact The McGraw-Hill Office Nearest You

ATLANTA, 3—1301 Rhodes-Haverty Bldg.
R. POWELL—*JAckson 3-6951*

BOSTON, 16—350 Park Square
M. J. HOSMER—*HUbbard 2-7160*

CHICAGO, 11—520 No. Michigan Ave.
W. HIGGENS—*MOhawk 4-5800*

CLEVELAND, 13—1164 Illuminating Bldg.
W. B. SULLIVAN—*SUperior 1-7000*

DALLAS, 2—1712 Commerce St., Vaughn Bldg. *Riverside 7-5177*
GORDON JONES—F. E. HOLLAND

DENVER—1700 Broadway, Tower Bldg.
J. PATTEN—*ALpine 5-2981*

DETROIT, 26—856 Penobscot Bldg.
J. R. PIERCE—*WOodward 2-1793*

LOS ANGELES, 17—1125 W. 6th St.
R. YOCUM—*HUntley 2-5450*

NEW YORK, 36—500 Fifth Ave. *OXford 5-5959*
H. T. BUCHANAN—R. P. LAWLESS
T. W. BENDER

PHILADELPHIA, 3—Six Penn Center Plaza *LOcust 8-4330*
H. W. BOZARTH—H. NICHOLSON

PITTSBURGH, 22—111 Oliver Bldg.
P. PIERCE—*EXpress 1-1314*

ST. LOUIS, 8—3615 Olive St.—*JEfferson 5-4867*

SAN FRANCISCO, 4—68 Post St.
S. HUBBARD—*DOuglas 2-4600*

FMC

HEADLINERS
in PROCESSING EQUIPMENT
A FEW of our BEST

DRYERS and EVAPORATORS

Stokes Rotary Jktd. Dryer; 18'x8'
Stainless Lined Rotary Dryer; 50"x20'
B & S Dbl. Drum Dryer; 28"x60"
Buflovak Dbl. Drum Dryer; 40"x120"
Zaremba INCONEL Dbl. Effect Evaporator
Swenson Multi Effect Long Tube, Film Type Evaporators

REACTORS and PRESSURE VESSELS

Mojonnier S/S Vac. Pans; 3'x10'; 6'x12'
Nickel Clad Reactor; 7'x11'6"; Jktd. Agt.
Struthers Wells Type 316 S/S; 1000-2000 Gal.
Pfaudler G1-Lnd; Jktd. Agtd. to 1000 Gals.
Lancaster S/S Lined Rotary Jacketed Reactor; 50" Dia. x 17'14" long
Three Stage Continuous Agitated Reactor, 3 Vessels 4'x20' in tandem
Dopp 650 Gal. C.I. Jktd. Agtd. Reactor
250 Gal. Hi-Pressure Forged Steel Reactor, Jacketed and Agitated; 40" x 72"

CENTRIFUGES and EXTRACTORS

Bird Continuous Conical Horizontal Centrifuges; 18"; 24"; S/S; Monel
Sharples H2 Nozzlejector; 15 HP
Sharples Monel Model M4 P Centrifuge
DeLaval Type 316 S/S Hermetic Separator
Fletcher 12" and 30" S/S Centrifugals
Rubber Covered Centrifugals; all sizes

FILTERS and FILTER PRESSES

Shriver and Sperry Filter Presses to 42" in Cast Iron, Stainless, Ni-Resist, Aluminum
Oliver Continuous Rotary Panel Type Vacuum Filters; 8'x8' and 8'x10'
Feinc String Type Rotary Vacuum Filters 6'x6' & 8'x10'; Stainless contacts
Bird Young Rotary Vacuum Filters 4'x4'
Sweetland Pressure Filters No. 2 to 12
Enzinger Vertical Stainless Pressure Filter; 18"x26"; ASME; 24 sq. ft.
Stainless Nutsche Type Filter 6' Dia. x 2'
Bowser Filter with Pump; 2000 GPH; 69 sq. ft.
Enzinger Leaf Type Filter, 48"x57" Tank with 15 leaves; 360 sq. ft. surface.

PLASTIC and RUBBER EQUIPMENT

F-B Late Style 2 Roll Rubber Mills, 14"x30"; 16"x42"; 18"x42"; 22"x60"
Three Roll Calender; 22"x58" complete
Baker Perkins Hv. Duty Mixers to 300 Gal.
Banbury Type "B" Laboratory Mixer
Two Adamson Vulcanizers; 16' long
Abbe Pebble Mills with Motors, Pebbles; 37"x48"; 45"x48"; 60"x72"; 8'x8'
Truck Dryers; 11'x15'x30'; 7'x12'x100'
Automatic Mechanical Dryer; 160' long
Automatic Washer for Latex Pads
Southwark Hydraulic Presses; 36"x36"
Dunning & Boschert Hydraulic Presses 36"x36"
French Oil Mill Presses; 28"x30"
Stokes Aut. Molding Press No. 252; 300 Ton
Extruders: Royle No. 1; Allen No. 2; NRM 1½"
Kux, Stokes & Colton Tablet Presses

Send for "FIRST FACTS" containing complete LISTINGS

FIRST MACHINERY CORP.
209-289 TENTH ST.
BROOKLYN 15, N. Y.
STerling 8-4672

CIRCLE M ON READER SERVICE CARD

MODERN REBUILT MACHINERY

UNION Rebuilt Machinery Established 1912

Stokes 90-D Automatic Stainless Steel Tube Filler and Closer.
Pneumatic Scale High Speed Automatic Cartoning Line with Feeder, Bottom Sealer, Top Sealer, Wax Liner, Interconnecting conveyors.
Standard Knapp, A-B-C, Ferguson and Ceco Case Sealers.
WRAPPERS: Package Machinery, Hayssen, Battle Creek, Scandia, Wrap-King, all sizes and models.
Stokes & Smith Model DD-2 Rotary Tablet Machine.
Werner & Pfleiderer 3,000 gal. and 3,500 gal. Jacketed Double Arm Mixers.
Baker Perkins, Day, W. & P. Heavy Duty Mixers, 2½ to 150 gal. caps.
Abbe 150 gal. S.S. Jacketed Mixer.
Day Experimental 2½ gal. Vacuum Jacketed "Mogul" Mixer, Sigma Blades.
W. & P. Jacketed 1100 gal. Heavy Duty Sigma Blade Mixer, 150 HP motor.
Colton 6 ft. diam. S.S. Revolving Pan.
Stokes & Smith Model G1, G2, G4, HG84, HG87 and HG88 Auger Powder Fillers.
Mikro Pulverizers, 15H, 2TH, 3TH and 4TH.
Fitzpatrick Stainless Steel Comminuters.

Complete Details and Quotations Available on Request

UNION STANDARD EQUIPMENT CO.

318-322 Lafayette St.
New York 12, N. Y.
CAnal 6-5333

167 N. May St.
Chicago 7, Illinois
SEely 3-7845

CIRCLE N ON READER SERVICE CARD

LOEB OFFERINGS

Autoclave: 50 gal. Struthers Wells, st. st.
Centrifugal: Tolhurst 20" st. steel (New).
Concentrating Table: Deister #14, 5' x 8'.
Dewaterers: Davenport 3A, bronze hd. 3 hp.
Disintegrator: Rietz RD18P, 75 hp.
Dryers: Devine 2 x 4' vac. drum, st. steel.
Dryer: Bowen lab. spray st. steel.
Evaporator: Buflovak st. st. 94 sq. ft.
Buflovak dbl. eff. model 850D.
Filter: Oliver precoat 12x2" st. steel.
Homogenizers-Disperser: Tri-Homo #10, #4
Kettles: st. steel, with and without ag.
Dopp 150 gal. dbl. act. agitator.
Mills: Mikro, 15H, 5 hp.
Day 3-roll high speed 14x30"
Mikro Atomizer type 5MA st. steel.
Colloid, 3, 5, 20, 25 hp.
Mixers: Dbl. and sgl. arms sigma blade.
Dry Powder, various sizes.
W. & P. size 14, 50 gal. jktd.
Mix-Muller: Simpson Porto 39" st. steel.
Pumps: Rotary, gear, centrif. vacuum.
Screen: Rotex model 41 st. steel.
Still: Double effect st. st. 11.83 gal.
Tablet Press: Stokes DD2, 23 station.
Truck Tanks: Stain. steel 1200, 1600 gal.
Vacuum Pans: 42" and 72" stain. steel.

LOEB EQUIPMENT SUPPLY CO.
[illegible] WEST SUPERIOR ST. CHICAGO 22, ILLINOIS

CIRCLE O ON READER SERVICE CARD

FOR SALE

3—Elliott steam turbo-blowers 33333 cfm at 10 psig.
1—18¾" x 24" Buckeye Steam Engine 336 H.P.
1—Connersville Blower 36" x 54". Size No. 11. 96 cu. ft. per rev.
1—225 H.P. Westinghouse Synchronous Motor with two (2) 75 K.W. D.C. generators. Transformer incl.
3—25 H.P. Allis Chalmers DC Motors.
1—Cummins Diesel Engine—Model S.P.S.D. H-6.
2—Bullock D.C. Generators 20 H.P.
3—Sturtevant Fans Design 4 Size 85.
1—25 H.P. Allis Chalmers Motor and 4" Centrifugal Pump.
1—Bowser Lubricating Oil Storage System (700 gal.)
32—Fulton Sylphon Steam Temp. Regulators. Style 921 Z/F.
1,000 ft. Spec. Corrugated Metalic Steam Hose ½" I.D.

Direct inquiries to:

Milwaukee Gas Light Company,
626 East Wisconsin Avenue, Milwaukee 1, Wis.
Attention Mr. R. Jochimsen,
Plants' Superintendent

CIRCLE P ON READER SERVICE CARD

BUY ON TERMS!

PFAUDLER REACTOR

500 gallon Model R. New in 1953. Turbine Agitator, baffle and Expl. proof Motor. Type 42 glass.

Excellent Condition

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE Q ON READER SERVICE CARD

Searchlight Equipment Locating Service

No charge or obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used equipment not currently advertised. (This service is for USER-BUYERS only.)

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Locating Service

Classified Advertising Division

CHEMICAL ENGINEERING

P. O. BOX 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
Classified Advertising Division
CHEMICAL ENGINEERING
P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following:

.....
.....
.....

NAME .....
TITLE .....
COMPANY .....
STREET .....
CITY .....ZONE.....
STATE 4/4/60

"OUTSTANDING VALUES"

Proctor-Schwartz 8' x 60' Apron Dryer, 3 Pass, Stainless Steel Apron. Complete
Sparkler 18-D-8 Stainless Steel Filter. Complete with Duramet Pump & Motor
Komarek-Greaves Briquetting Press, Rolls 36" dia x 9½" face. 40 HP Motor
Raymond Model 49 Imp. Mill. New set of Hammers. Last used with 50 HP
Oliver 3' x 2' type 316 Rot. Continuous Vacuum Filter. Fully equipped
Patterson 6' x 8' Porax Lined Pebble Mill. 20 HP expl. proof Motor
Alco Products 735 sq ft type 316 S.S. Heat Exchanger, 200-1" O D tubes 16'
Downington 54 sq ft type 316 S.S. Heat Exchanger. 1" tubes, Outer shell S.S.

For immediate quote, wire or phone collect—GA 1-1380

MACHINERY AND EQUIPMENT COMPANY
123 Townsend St. · San Francisco 7, California

CIRCLE S ON READER SERVICE CARD

DIESEL LOCOMOTIVES & CRANES

3—New 25 Ton, 2 GE I Whitecomb.
3—23 Ton, 2-45 Ton Used Gen. Elec.
1—44 Ton, 1-80 Ton Used Gen. Elec.
3—100 Ton, Gen. Motors, Used
1—25 Ton, Industrial 60' Boom Loco. Crane.

PLANT EQUIPMENT

2—Wemco 2M-HMS-Plants.
36 x 42 Jeffrey Hammermill, Type B-2.
No. 5060 Dixie Mogul Hammermill 500 H.P.
2—6' x 30" Hardinge Ball Mills.
2—5' x 8' Kennedy Van-Saun air swept Ball Tube Mills with Motors & Elec. Eqs.
7' x 24' Allis-Chalmers Tube Mill.
5' x 10' & 7' x 15' Rod Mills.
14" x 28" New England Jaw Crusher.
30" x 36" Traylor Type H Jaw Crusher.
48" x 72" Buchanan Type "G" Jaw Crusher
56" x 72" Traylor Style G Jaw Crusher.
No. 1 Sturtevant Rotary Fine Reduction.
2' Symons Standard Cone Crusher.
36" x 20' Ruggles Coles Class XF-1 Rotary Dryer.
#207-10 & #705—24 Link Belt Roto Louver Dryers.
Link-Belt Mono-Tube 24-10 Dryers.
54" x 35' Louisville Monel Steam Tube Dryer.
72" x 28' Madson Rotary Dryer.
5' x 30' Ruggles Coles Class XA-8 Rotary Dryer.
6' x 60' Rotary Dryer, ½" Welded Shell in Calif.
9' x 160' Vulcan Rotary Kiln.
42" x 18" Traylor Type AA Crushing Rolls.
5'0" x 60' Rotary Dryer or Cooler.
F55 Syntron Grizzley Feeder
30" x 95' NEW Hewitt Robins Truss Belt Conveyor

R. C. STANHOPE, INC.
60 E. 42nd St. N. Y. 17, N. Y.
Tel. MU 2-3075

CIRCLE T ON READER SERVICE CARD

COMPRESSORS

World's Best Rebuilts

74 CFM	1500 PSI	6½-3¾-1¾x7 CP. TCB3
100 CFM	150 PSI	6x7 Ing. ES-1
104 CFM	2580 PSI	6¾-4¼-1 11/16x9 IR-ES3
110 CFM	3000 PSI	Ing. GC 50BW
138 CFM	100 PSI	7x7 Ing., Ing. ES, CP & Jay
151 CFM	3000 PSI	13¾x12 Norwalk TRS-4T
258 CFM	100 PSI	9x9 Ing. Worth. CP & Penn
311 CFM	1500 PSI	10½-7½-3½x13 IR-ES3
351 CFM	350 PSI	11-5x11 CP TCB-2
465 CFM	100 PSI	12x11-IR-ES-1-Chic. P.T.
502 CFM	125 PSI	12x13 Chic. T
686 CFM	100 PSI	14x13 Ing. ES-Chic. P.T.
823 CFM	Vac. 16x7	Ing. ES-1
877 CFM	125 PSI	17-10½ IR. XRB
1545 CFM	110 PSI	21-13x14 Ing. XRE
	3/60/440	80% PF
2380 CFM	50 PSI	19-19x14
3135 CFM	Vac	31x13 Ing. ES Worth HB

AMERICAN AIR COMPRESSOR CORP.
Chem. Road, North Bergen, N. J. UNion 5-1397

CIRCLE W ON READER SERVICE CARD

STAINLESS STEEL TANKS

Oxygen cylinder, J-1, 24" x 45", 77 gal., 18,000 cu. in., 400 PSI 10 gauge, type 304. Value $300.
NEW ¼" pipe thread both ends **$99.50** Ship. wt. 250 lbs.

Model F-1, 8½" x 18", wt. 14 lbs., 1,000 cu. in. type 302 and 304, gauge 16. Packed 8 to carton. **$14.50** NEW

Air Force surplus. Ideal for chemicals, gases, pneumatic use, hydraulic, liquids, etc. Prompt shipment. Terms 30 days net, F.O.B. Baton Rouge, La.

ILLINOIS MFG. & SUPPLY CO.
1829 S. State Street, Chicago 16, Illinois, Dept. 10
Phone Victory 2-6633

CIRCLE X ON READER SERVICE CARD

BALL MILLS—3' x 12' Abbe/40 HP—4' x 6' Allis Chalmers 60 HP Slip Ring/screwfeeder—Kennedy Van Saun 5' x 6' Enclosed gears/50 HP/scales/feeders/exhausters—Hardinge 6' x 12' w/200 HP Slip Ring/drum feeder.

HAMMERMILLS—20 HP Gruendler X—30 HP Mikro 3W—40 HP Jeffrey 24 x 20—50 HP Wms. AKBX—100 HP Jeffrey 36 x 42—450 HP Penna SXT 14.

ROTARY DRYERS—24" x 22'—36" x 24'—44" x 25'—5' x 50' (2) all w/motor drives—burners/blowers avail.

VACUUM PUMPS—115 CFM Beach Russ 100 RP w/5 HP motor/Vee belt drive.

SCALES—12500# capacity dial—Fairbanks Printomatic—8' x 6' Platform.

FEEDERS—Syntron FMI,—FM3—w/hoppers/vibrators/controls.

YOUR BEST REBUILT MACHINERY SOURCE

LAWLER COMPANY
Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE U ON READER SERVICE CARD

OUTSTANDING VALUES!

1—Hersey 1½' x 16' hot Rotary Dryer.
1—Mikro Pulverizer model 4-TH.
2—Rotex double deck Sifters 40" x 120".
3—Sparkler 33-S17 rubber lined Filters.

CHEMICAL & PROCESS MACHINERY CORP.
50-52 9th St., Brooklyn 15, N. Y. HY-9-7200

CIRCLE Y ON READER SERVICE CARD

MOVING SALE

Exceptional good buys available.
Come in and see for yourself.

EQUIPMENT CLEARING HOUSE, INC.
111 33rd Street, Brooklyn, N. Y.
SOuth 8-4451—4452—8782

CIRCLE V ON READER SERVICE CARD

Dryers, Kilns, Centrifugals, Filters, Kettles, Tanks, Grinders, Crushers, Mixers, Screens, Tablet Machines, etc. Hydraulic, Plastic and Rubber Machinery. Send for bulletins.

STEIN EQUIPMENT CO.
107—8th STREET BROOKLYN 15, N. Y.
Sterling 8-1944

CIRCLE Z ON READER SERVICE CARD

SENSATIONAL OFFERINGS for GELBS 75th YEAR

1—18,000 gal. type 316 SS PRESSURE TANK 11' x 24', 60 psi

3—Struthers Wells Type 316 SS JACKETED REACTORS, 2000 gal., complete with agitators and drives. 40# internal pressure

1—Pfaudler SS 10 gal. JACKETED REACTOR, complete with impeller type agitator and drive, 100 psi internal, 78 psi jacket

1—Struthers Wells type 347 SS PRESSURE VESSEL with coils, 300 gal.

4—Lee SS 1000 gal. STORAGE TANKS with coils

4—Davis Engineering Carpenter 20 HEAT EXCHANGERS, 120 sq. ft., each, (new)

1—Buflovak SS jacketed ROTARY VACUUM DRYER, 3' x 15'

1—Louisville rotary steam TUBE DRYER, 8' x 45'

1—Western States Model UD Type 316 SS under-driven CENTRIFUGE with 36" perforated basket complete with unloader and motor

1—Fletcher SS 40" under-driven CENTRIFUGE with perforate basket

1—Vulcan SS bubble cap COLUMN, 4' dia. x 28 plates

1—Oliver SS rotary pressure precoat FILTER, 5'3" x 8'

SEE OUR OTHER LISTINGS

CIRCLE AA ON READER SERVICE CARD

THE GELB GIRL—APRIL 1960

AUTOCLAVES, KETTLES AND REACTORS

1—Type 316 SS 2000 gal. horizontal tank
1—Pfaudler Series EL, glass lined jacketed reactor, 300 gal., complete with anchor type agitator and drive
2—Pfaudler 200 gal. glass lined jacketed, reactors complete with anchor type agitators and drives
1—Pfaudler 100 gal. glass lined jacketed reactor, complete with anchor type agitator and drive
1—Pfaudler 100 gal. glass lined vacuum receiver
1—Steel and Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi jacket
1—Blaw Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket
1—Blaw Knox 45 gal. jacketed autoclave, 1500# pressure
1—Patterson Kelley 6000 gal. steel jacketed kettle
2—Steel jacketed reactors 2500 gal.

DRYERS

3—Link Belt steel roto louvre dryers, Model 207-10, 310-16, 604-20
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
2—Louisville rotary dryers, 8' x 50', SS
1—Louisville rotary dryer, 38" x 40', Type L
1—Traylor 4' x 40' rotary dryer
1—Rotary dryer, 6' x 36'
2—Stokes Model 138J-20 single door vacuum shelf dryers, 20 shelves, complete
1—Western Precipitation Corp. SS pilot spray dryer, Type N-2
1—Proctor & Schwartz all stainless steel tray dryer

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
1—Sweetland #3 stainless steel filter
12—Sweetland #12 filters with 72 SS leaves
1—Niagara SS filter, Model 510-28
1—Oliver horizontal filter, 3'
10—Shriver plate and frame filter presses, 12" to 42"
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers
1—Shriver C.I. plate and frame filter press, 36" x 36", closed delivery, 4 eye, 60 chambers

ADVERTISERS

Advertising Sales Representatives

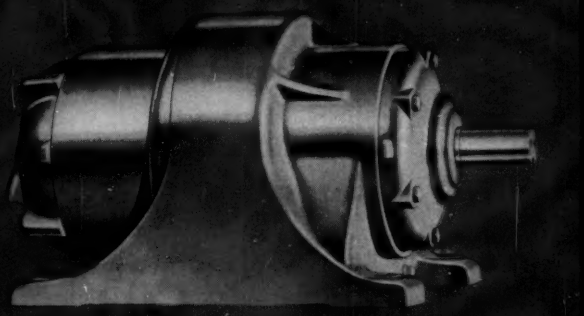
Atlanta 3 ..... W. O. Crank
1301 Rhodes-Haverty Bldg., JAckson 3-6951
Boston 16 ..... A. S. Reed
350 Park Square Bldg., HUbbard 2-7160
Chicago 11 ..... D. Gridley, J. M. Rodger, Jr.
520 N. Michigan Ave. MOhawk 4-5800
Cleveland 13 ..... L. J. Biel
55 Public Square SUperior 1-7000
Dallas 1 ..... Robert T. Wood
Vaughn Bldg., 1712 Commerce
Riverside 7-5117
Denver 2 ..... John Patten
1700 Broadway Alpine 5-2981
Detroit 26 ..... Chas. M. Crowe, Jr.
856 Penobscot Bldg. WOodward 2-1793
Frankfort/Main ..... Stan Kimes
85 Westendstrasse
Geneva ..... Michael R. Zeynel
2 Place du Port
London EC4 ..... E. E. Schirmer
95 Farringdon St.
Los Angeles 17 ..... John B. Uphoff
1125 W. Sixth St. HUntley 2-5450
New York 36, R. G. Frederick, A. L. Gregory, John R. Emery
500 Fifth Ave. OXford 5-5959
Philadelphia 3 ..... E. M. Schellenger
6 Penn Center Plaza LOcust 8-5330
Pittsburgh 22 ..... G. S. Ryan
1111 Oliver Bldg. EXpress 1-13-1
San Francisco 4 ..... Scott Hubbard
68 Post St. DOuglas 2-4600
St. Louis 8 ..... J. M. Rodger, Jr.
3617 Olive Street JEfferson 5-4867

ADVERTISERS . . .

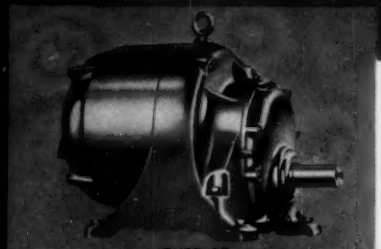
CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

ADVERTISERS INDEX



TYPE GH
SINGLE REDUCTION SYNCROGEAR
1/3 TO 30 H.P.



TYPE GR
SINGLE REDUCTION SYNCROGEAR
1/6 TO 20 H.P.

whatever you need in geared power... whatever the speed...whatever the horsepower...specify

U.S. Syncrogear...now with gears honed to super finish!

Again U.S. introduces a new first in gearmotor design: Gears *honed to super finish* for quiet, smooth running and longer life. A long succession of Syncrogear innovations by U.S. during the last 25 years have been widely adopted. **Through-hardening** of gears... the **solid-shank pinion**... the sturdy **"pyramidal" base**... **micro-shaving** of gears... solid cast **one-piece case**..."crowned" helical gear teeth of **elliptoidal design**... all these add years of trouble-free operation to Syncrogear life. To assure precision, U.S. makes its own gears. For more information on U.S. Syncrogear features, send for free color brochures: Syncrogear Bulletin No. F-1880, Right-Angle Worm-Gear Syncrogear Bulletin No. F-1650, or Shaftmount Syncrogear Bulletin No. F-1994.

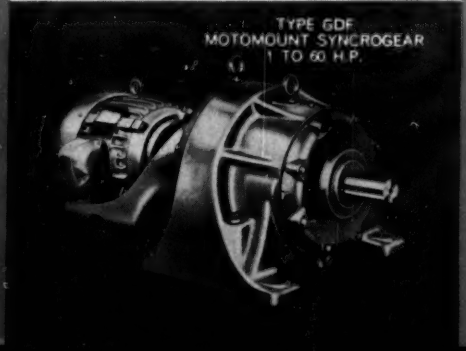
TYPE GW
RIGHT-ANGLE, WORM-GEAR
SYNCROGEAR
1/3 TO 2 H.P.

TYPE GDV
VERTICAL SYNCROGEAR
3 TO 30 H.P.

U.S. ELECTRICAL MOTORS INC.
P.O. Box 2058 • Los Angeles 54, California, or Milford, Connecticut

You are cordially invited to visit our **booths, 1704-1706,** at the Design Engineering Show in New York's Coliseum, **May 23 through 26.**

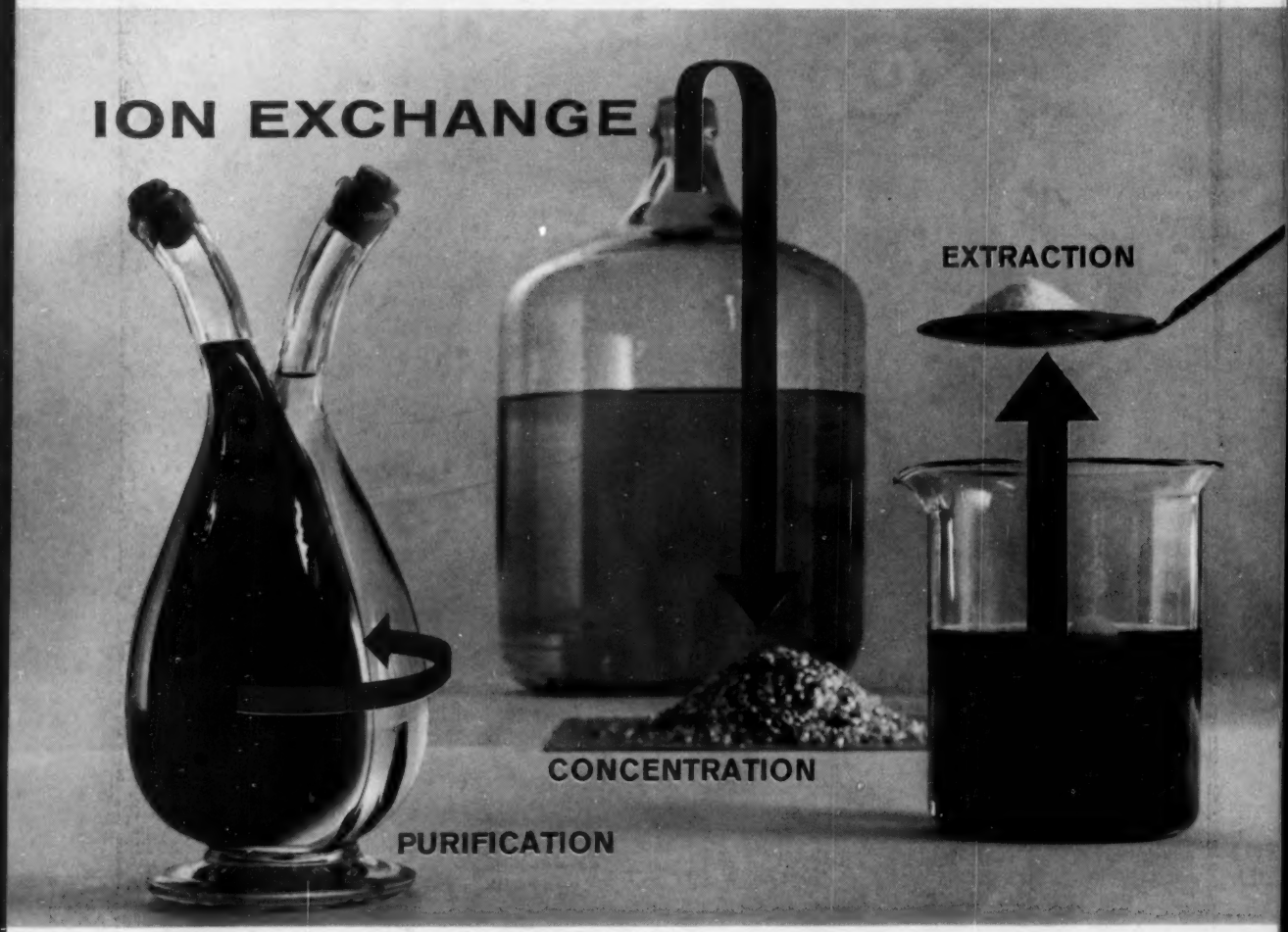
TYPE GM
TRIPLE REDUCTION SYNCROGEAR
1 TO 10 H.P.



TYPE GDF
MOTOMOUNT SYNCROGEAR
1 TO 60 H.P.

TYPE GC
SHAFTMOUNT SYNCROGEAR
1/4 TO 40 H.P.

FLUIDICS* AT WORK



0.1% in solution . . . how to handle practically and profitably . . . consider Permutit Ion Exchange

Ion exchange, the Permutit way, is a standard, unit operation for: Purification, Concentration, Separation and Addition.

It is a versatile process involving many types of dilute solutions.

Unified responsibility. As with any unit operation, success is related to coordination. In the case of ion exchange at Permutit, this encompasses conceptual system design, process engineering, equipment design and fabrication, and service of the completed installation.

Not the least is the ion exchanger employed. As the only manufacturer of both resins and equipment, Permutit is best able to control the ion exchange operation from beginning to end.

You get this complete, unified approach when you work with Permutit. Pioneering the field since 1912, Permutit offers a fund of ion exchange technology, equipment and resins, unmatched by any other group.

Rely on any or all of our services:

1. Technical assistance. Your problem and process will be thoroughly and expertly evaluated in terms of what ion exchange can do.

2. Wide choice of resin. From among Permutit's more than 30 ion exchangers, those best suited for your needs will be specified. In this wide selection you'll find many unique and specialized cation and anion exchangers, mixtures and miscellaneous adsorbents.

3. Dollar-saving equipment. Frequently the equipment you need is already available as a "package" or can be quickly assembled from standard, stocked components. Naturally, custom units are also part of our service, and automatic equipment was pioneered by Permutit.

FLUIDICS and you. This total approach is part of Fluidics at work—the Pfaudler Permutit program that applies the science of fluid processes to profitable solutions for problems involving liquids or gases.

If you're interested in ion exchange, either (a) send for a 12-page booklet, "Permutit Ion Exchangers" or (b) send us an outline of your problem. Write to our Permutit Division, 50 West 44th Street, New York 36, N. Y.

OVER 30 ION EXCHANGE RESINS are available from Permutit, along with the know-how and equipment that can help you get the most from this recognized unit operation. Samples on request.

FLUIDICS AROUND THE WORLD

Pfaudler Permutit is a world-wide company with manufacturing plants in Germany, Great Britain, Canada, Mexico, Japan and four in the United States.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes